Final Report

on the

Urban Hydrology Study of Ross Creek Watershed

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FINAL REPORT

on the

Urban Hydrology Study of Ross Creek Watershed

prepared for

Santa Clara Valley Water District

prepared by

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CONTENTS

Page

Objective --1

Extent of Completion ---------------------------------------2

Introduction ---3

The Basin --4

Data and Methodology ---------------------------------------6

Computer Program HEC-1 ------------------------------------23

Optimization --24

Subarea Delineation and Hydrograph Generation ------------25

Routing Method --26

Rainfall Distribution -------------------------------------28

Parameter Adjustment and Reconstitution ------------------30

Conclusion --34

Recommendation --36

Reference ---37

Appendix A: Tables of Parameter Adjustment ---------------38

Appendix B: The Selected Computer Outputs ----------------46

OBJECTIVE

The broad objective of this urban hydrology study of the Ross Creek Watershed was to assist the Santa Clara Valley Water District (SCVWD) with its reevaluation of their urban hydrology methodology[1]. A key feature of the study was to be a new attempt to relate fitted hydrograph parameters to physical characteristics of the basin, and from this to develop a procedure to calculate design flows from the physical characteristics of the urban watersheds.

More specifically, the major components of this study were to include :

(1) Preparation of information and data on the drainage areas, precipitation gaging stations, stream gaging stations, precipitation, and streamflows;

(2) Characterization of the watershed, including its division into subareas, pervious and impervious portions;

(3) Investigation of the variation of routing (storage/discharge) relations with land use and size of drainage area;

(4) Use of the Corps of Engineers computer program HEC-1 to determine, for each subarea, the hydrologic parameters which characterize Clarke's synthetic unit hydrographs for the pervious and impervious portions;

(5) Determination of regression equations which relate the above-mentioned hydrologic parameters to physical characteristics of the subareas, and from those development of a procedure to calculate design flows from physical characteristics;

(6) Verification of the design flow methodology on different storms; and

(7) Writing a final report.

EXTENT OF COMPLETION

About half way through this project it became clear that step 4 above, which tried to match complete hydrographs to observed ones, was far more complicated than originally anticipated. Near the three-quaters point, it became very apperent that the accuracy of the hydrologic parameters determined in step 4 was still not good enough to justify the step 5 regression study, and therefore that the full scope could not be completed within budget. In a joint decision with the SCVWD staff, it was then decided to devote the remainder of the budget to improving the results of step 4 and to writing the final report (step 7).

Some further improvement of step 4 was achieved, and steps 5 and 6 were not attempted. Because full completion of step 3, and to a lesser extent step 2, depended somewhat on a good flow modeling capability which is not achieved in step 4, these two steps were not completed to our satisfaction. For step 2, there only remains some uncertainty of the pervious and impervious allocations. For step 3, it was only possible to investigate the sensitivity of the modeling process to changes in the storage/discharge relation. Steps 1 and 7 have been completed.

INTRODUCTION

This study used the HEC-1 computer program of the Army Corps of engineers to model urban hydrology behavior[2]. Because of the complicated characteristics of urban areas, there are many parameters and special situations which need to be considered in the calibration process. In our efforts to achieve the best simulations, we adjusted the parameters based on previous experience and on comparisons of hydrographs computed from rainfall records at nearby stations with the observed hydrographs from flowrate records for the two gaging stations on Ross Creek.

In the following sections, we briefly introduce the basin studied, its data, and the HEC-1 program. We first ran optimizations on both subarea A (based on the flow records for station #21) and on the whole basin (based on flow records for station #51), to obtain guidlines for later adjustments of the key parameters including time of concentration, routing coefficient and loss rate parameters. For the whole basin those parameters were optimized rather roughly because of the large area and hence more varied characteristics. For a smaller area such as subarea A, the optimization can give better results, as discussed later. Following the optimizations, investigation procedures included (1) adjusting subarea boundaries, (2) testing alternative routing methods, (3) investigating the effects of various areal rainfall distributions on the outflow hydrographs, and (4) testing and adjusting important controlling parameters, such as the three loss rate parameters, the hydrograph recession rate, the time of concentration, and the routing coefficient of Clarke's synthetic unit hydrograph, in order to reconstitute the outflow hydrographs.

The four procedures just mentioned are further described and discussed in later sections. In appendicies this report also presents tables of parameters and constants used for the different approaches, and comparisons of computed and observed hydrographs. Information on eighty four computer runs is included.

THE BASIN

The Ross Creek basin is shown in Fig. 1. Its total area is 9.96 square miles. The basin covers both a southwestern part of San Jose and the upper part of Los Gatos. It is divided into eight subareas. There are rural, hilly areas in most of subarea A and in small parts of subareas B and H. The other subareas, I, J, L, M, and N, are all urbanized areas. Ross Creek originates in subarea A and discharges into the Guadalupe River. The basin studied, however, ends at streamflow gaging station #51 in subarea N, about 3,000 ft upstream from the Guadalupe River. Most of the contributing urbanized areas are medium-density residential, except for small parts of subareas N and M which are high-density residential areas. Some schools and parks are also included.

The triangles on Fig. 1 locate the two stream-flow gaging stations, #21 and #51. The circles numbered 1 to 6 represent the flow collection points of the subareas; for example, point 3 is the collection point for subarea H and point 4 is the collection point for subareas I and J.

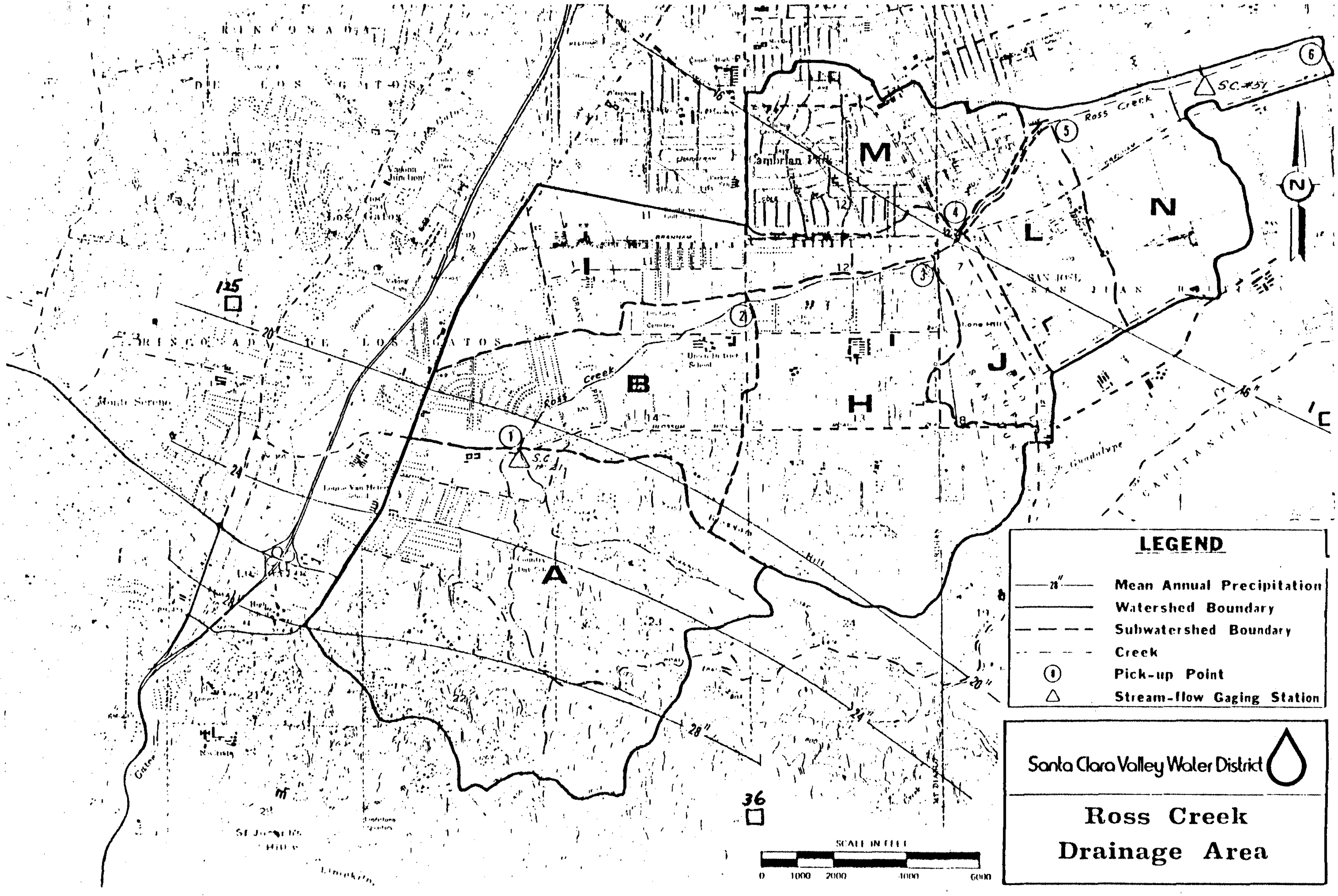


Fig. 1 *The Ross Creek Waterbasin map*

DATA & METHODOLOGY

Input data are organized into three categories: precipitation data, parameters and constants, and streamflow data. Listing of the precipitation and streamflow data at 15 minute intervals were provided by the SCVWD.

Precipitation data have been collected at several SCVWD rainfall recording stations. From them, Stations 1, 36, and 125, which form a triangle covering the basin (see Fig. 1), were chosen to best provide local rainfall records at fifteen minute intervals. Records for ten complete storms were available. We chose more concentrated storms, which had clearer peaks, for our initial hydrograph parameter calibration purpose. Storm 1 was used initially in the calibration process to test, adjust, and then generate a good set of model parameters. Storms 2 and 5, which have similiar shapes to Storm 1, were chosen to check our adjusted parameters. The results are given in later sections. Fig. 2 shows the rainfall distributions for the ten storms based on basin average records. These distributions were used initially, with basin average precipitations taken to be applied equally over the entire basin. Theissen and isohyetal rainfall distributions were later tested, in which the gage records for the different subareas were weighted in accordance with the respective methods. The hydrographs generated from these two methods, as shown on the computer outputs, were actually only slightly different from each other but do improve the model parameters from those obtained by using the basin average rainfall distribution. This may be seen by

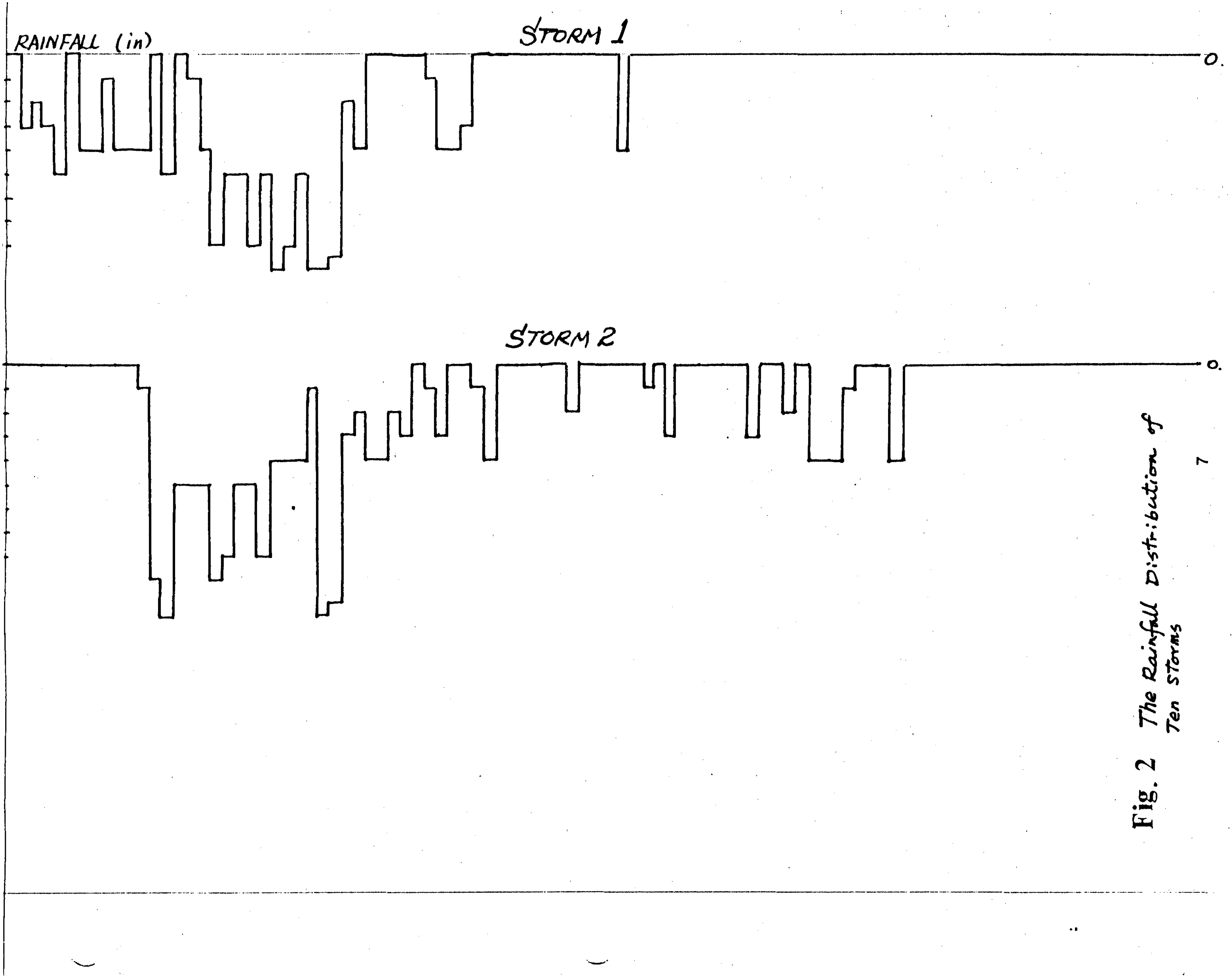
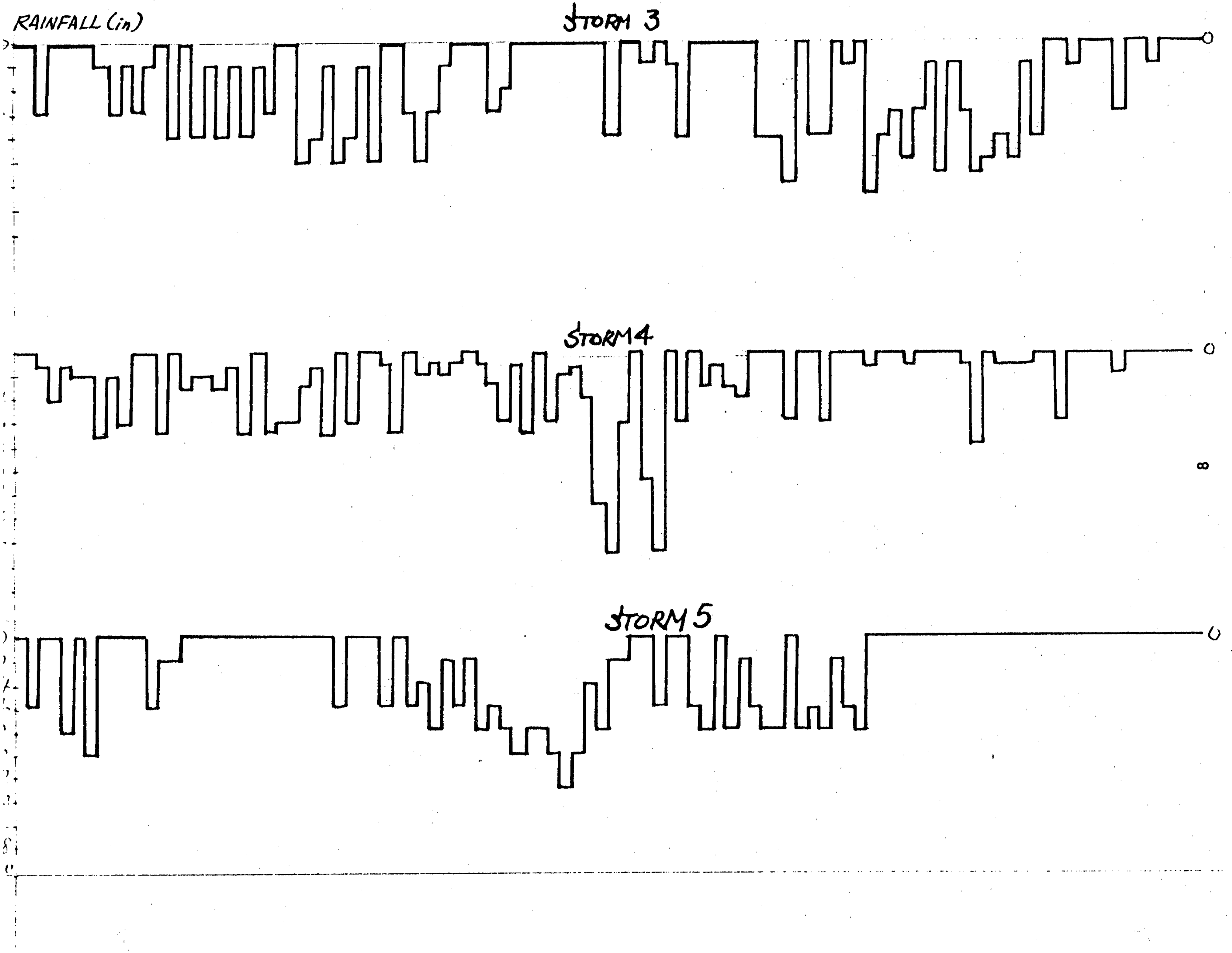
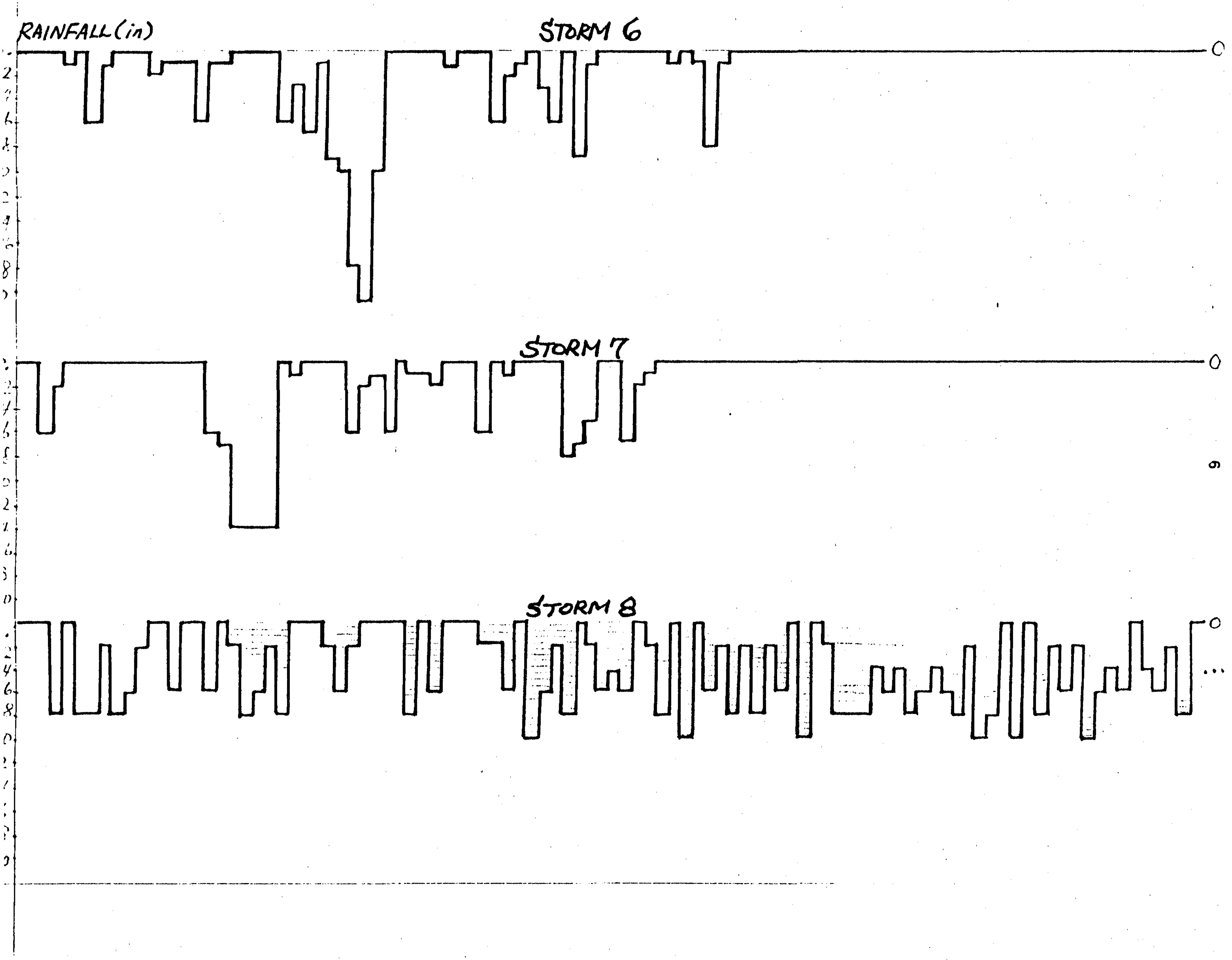


Fig. 2 The Rainfall Distribution of Ten Storms


RAINFALL (in)
STORM 3
0
STORM 4
0
8
STORM 5
0


RAINFALL (in)
STORM 6
0
STORM 7
0
STORM 8
0
2
4
6
8

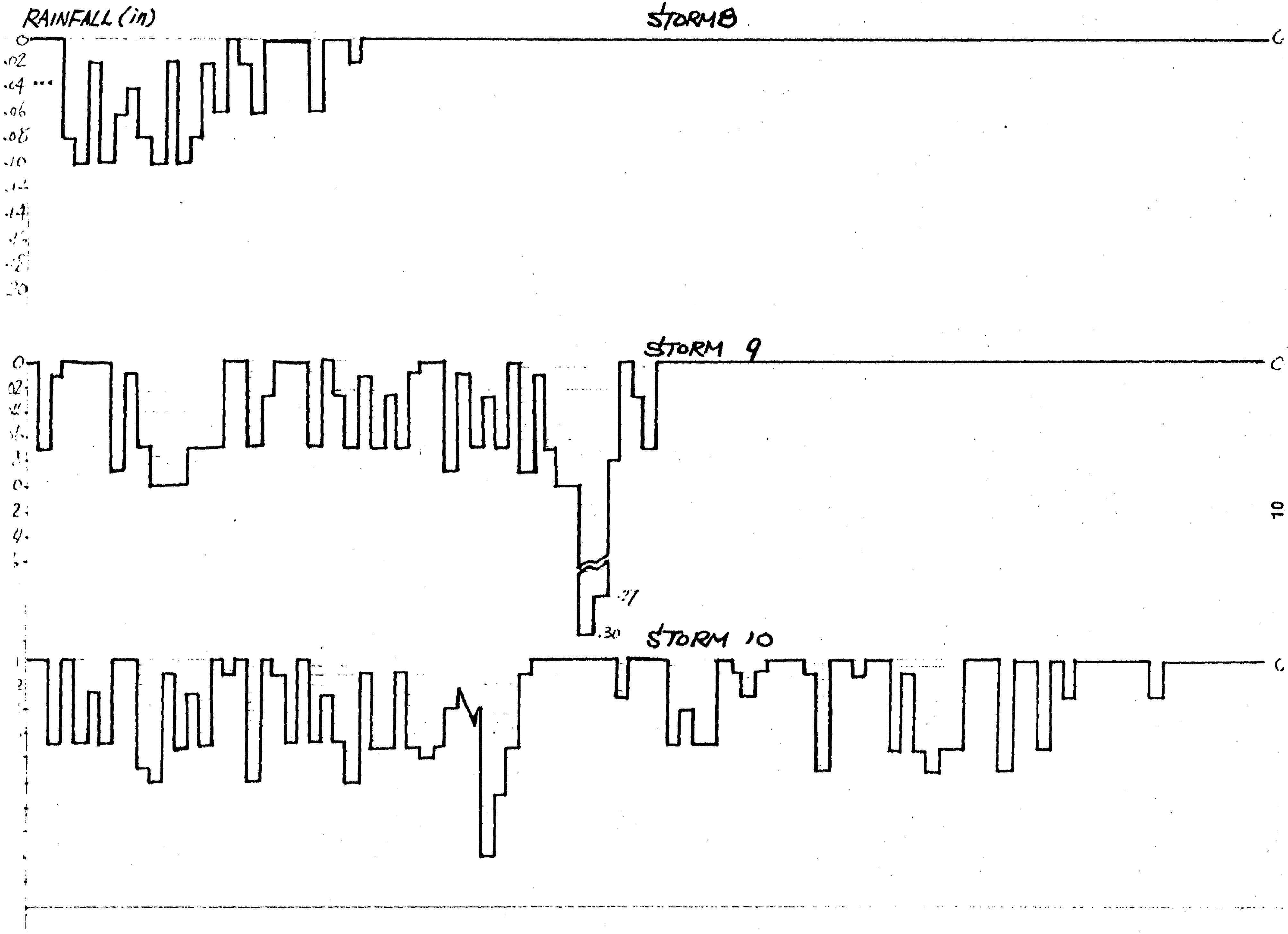

RAINFALL (in)
STORM 8
0
.02
.04
.06
.08
.10
.12
.14
.16
.18
.20
0
STORM 9
0
.02
.37
.30
0
STORM 10
0

Table 1 isohyetal rainfall distribution of the subareas A through N

STORM # I

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
1	.059	.086	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
2	.039	.012	.0	.049	.083	.0	.093	.078	.098	.049	.098	.098	.098	.074	.098	.098	.098
3	.059	.086	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
4	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
7	.078	.049	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
8	.020	.049	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
9	.078	.049	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
10	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
11	.078	.049	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.074	.064	.098	.098
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
15	.020	.049	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
16	.078	.049	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
17	.157	.147	.196	.147	.113	.196	.103	.118	.098	.147	.098	.098	.098	.122	.098	.098	.098
18	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
19	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
20	.157	.147	.196	.147	.113	.196	.103	.118	.098	.147	.098	.098	.098	.122	.098	.098	.098
21	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
22	.176	.147	.196	.147	.113	.196	.103	.118	.098	.196	.098	.196	.157	.152	.162	.196	.196
23	.157	.147	.196	.147	.113	.196	.103	.118	.098	.147	.098	.098	.098	.122	.098	.098	.098
24	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
25	.176	.196	.196	.098	.196	.196	.196	.196	.196	.147	.196	.098	.137	.167	.132	.098	.098
26	.176	.184	.196	.196	.113	.196	.103	.118	.098	.196	.098	.196	.157	.152	.162	.196	.196
27	.167	.259	.294	.147	.044	.294	.015	.059	.0	.147	.0	.0	.0	.074	.0	.0	.0
28	.039	.012	.0	.147	.083	.0	.093	.078	.098	.049	.098	.098	.098	.074	.098	.098	.098
29	.078	.086	.098	.049	.015	.098	.005	.020	.0	.098	.0	.0	.059	.054	.064	.0	.0
30	.0	.0	.0	.049	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
31	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
33	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
34	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
35	.020	.0	.0	.0	.0	.0	.0	.0	.0	.049	.0	.098	.059	.029	.064	.098	.098
36	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
37	.078	.086	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
38	.059	.086	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
39	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
41	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
42	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
43	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
44	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
45	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
46	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
47	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
48	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
49	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
50	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Table I Continued

STORM # 1

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
51	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.069	.039	.069	.034	.069	.069
52	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
53	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
54	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
55 56	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
57 58	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
59 60	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
61 62	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
63 64	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
65 66	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
67 68	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
69 70	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
71 72	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
73 74	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
75 76	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
77 78	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
79 80	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃
TOTAL	2.851	3.062	3.332	2.695	2.249	3.332	2.122	2.313	2.058	2.793	2.058	2.225	2.216	2.431	2.220	2.225	2.225

Table 1 --continued

STORM # 2

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.02	.012	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.04	.045	.035	.0	.0
13	.176	.196	.196	.196	.196	.196	.196	.196	.196	.147	.196	.098	.137	.167	.132	.098	.098
14	.206	.271	.294	.196	.127	.108	.108	.137	.098	.196	.098	.098	.098	.147	.098	.098	.098
15	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
16	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
17	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
18	.176	.184	.196	.147	.113	.196	.103	.118	.098	.196	.098	.196	.157	.152	.132	.196	.196
19	.157	.184	.196	.147	.113	.196	.103	.118	.098	.147	.098	.098	.098	.122	.098	.098	.098
20	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
21	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
22	.157	.184	.196	.147	.113	.196	.103	.118	.098	.147	.098	.098	.098	.122	.098	.098	.098
23	.078	.086	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
24	.078	.098	.098	.098	.083	.098	.098	.098	.098	.049	.098	.0	.040	.069	.034	.0	.0
25	.078	.086	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
26	.02	.012	.0	.049	.098	.0	.093	.078	.098	.0	.098	.0	.040	.044	.034	.0	.0
27	.206	.271	.294	.196	.127	.294	.108	.137	.098	.196	.098	.098	.098	.147	.098	.098	.098
28	.196	.086	.196	.147	.113	.196	.103	.118	.098	.245	.098	.294	.216	.181	.225	.294	.294
29	.059	.184	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
30	.039	.012	.0	.049	.083	.0	.093	.078	.098	.049	.098	.098	.098	.074	.098	.098	.098
31	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.040	.067	.035	.0	.0
32	.078	.086	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.057	.054	.064	.098	.098
33	.039	.012	.0	.049	.083	.0	.093	.078	.098	.049	.098	.098	.098	.074	.098	.098	.098
34	.059	.086	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
35	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
36	.02	.012	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.04	.044	.034	.0	.0
37	.059	.086	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
38	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
39	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40	.02	.012	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.035	.0	.0
41	.078	.086	.098	.049	.015	.098	.005	.02	.0	.098	.0	.098	.059	.054	.064	.098	.098
42	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
43	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
44	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
45	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
46	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
47	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
48	.039	.012	.0	.049	.083	.0	.093	.078	.098	.049	.098	.098	.098	.074	.098	.098	.098
49	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
50	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Table 1 --continued

STORM # 2

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
51	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
52	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
53	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
54	.020	.012	.0	.049	.083	.0	.093	.078	.0	.0	.0	.0	.039	.044	.034	.0	.0
55	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
56	.059	.085	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
57	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
58	.0	.0	.0	.0	.0	.0	.0	.0	.098	.0	.098	.0	.0	.0	.0	.0	.0
59	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
62	.059	.085	.098	.049	.015	.0	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
63	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
64	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
65	.039	.012	.049	.083	.098	.093	.078	.098	.049	.098	.098	.098	.074	.098	.098	.098	.098
66	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
67	.078	.098	.098	.098	.098	.0	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
68	.078	.085	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.044	.098	.098
69	.078	.085	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
70	.020	.012	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
71	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
72	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
73	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
74	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
75	.078	.085	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
76	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
77	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
78	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
79	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
80	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	3.116	3.214	3.430	3.038	2.695	3.430	2.499	2.646	2.548	3.136	2.548	2.548	2.548	2.793	2.519	2.548	2.548

Table 1 --continued

STORM # 4

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.024	.012	.025	.039	.039
4	.039	.01	.0	.049	.083	.0	.093	.078	.098	.039	.098	.078	.047	.068	.083	.078	.078
5	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.024	.012	.025	.039	.039
6	.02	.0	.0	.0	.0	.0	.0	.0	.0	.039	.0	.078	.047	.024	.051	.078	.078
7	.02	.0	.0	.0	.0	.0	.0	.0	.0	.039	.0	.078	.047	.024	.051	.078	.078
8	.069	.088	.098	.049	.015	.098	.005	.02	.0	.049	.0	.078	.047	.048	.051	.078	.078
9	.02	.0	.0	.0	.0	.0	.0	.0	.0	.039	.0	.078	.047	.024	.051	.078	.078
10	.059	.088	.098	.049	.015	.098	.005	.02	.0	.049	.0	.0	.0	.025	.0	.0	.0
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	.069	.088	.098	.049	.015	.098	.005	.02	.0	.069	.0	.039	.024	.042	.025	.039	.039
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
15	.029	.01	.0	.049	.083	.0	.093	.078	.098	.02	.098	.039	.063	.047	.060	.039	.039
16	.02	.0	.0	.0	.0	.0	.0	.0	.0	.039	.0	.078	.047	.035	.051	.078	.078
17	.02	.0	.0	.0	.0	.0	.0	.0	.0	.039	.0	.078	.047	.024	.051	.078	.078
18	.029	.01	.0	.049	.083	.0	.093	.078	.098	.069	.098	.039	.063	.056	.060	.039	.039
19	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.024	.012	.025	.039	.039
20	.069	.088	.098	.049	.015	.098	.005	.02	.0	.02	.0	.039	.024	.036	.025	.039	.039
21	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
22	.069	.088	.098	.049	.015	.098	.005	.02	.0	.02	.0	.039	.024	.036	.025	.039	.039
23	.059	.088	.098	.049	.015	.098	.005	.02	.0	.0	.0	.0	.0	.025	.0	.0	.0
24	.059	.088	.098	.049	.015	.098	.005	.02	.0	.0	.0	.0	.0	.025	.0	.0	.0
25	.029	.01	.0	.049	.083	.0	.093	.078	.098	.098	.069	.039	.063	.056	.060	.039	.039
26	.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.02	.039	.024	.012	.025	.039	.039
27	.069	.088	.098	.049	.015	.098	.005	.02	.0	.0	.02	.039	.024	.036	.025	.039	.039
28	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
29	.059	.088	.098	.049	.015	.098	.005	.02	.0	.0	.0	.0	.0	.025	.0	.0	.0
30	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
31	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.024	.012	.025	.039	.039
33	.069	.088	.098	.049	.015	.098	.005	.02	.0	.02	.0	.039	.024	.036	.025	.039	.039
34	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
35	.02	.0	.0	.0	.0	.0	.0	.0	.0	.039	.0	.078	.047	.024	.051	.078	.078
36	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.024	.012	.025	.039	.039
37	.02	.01	.0	.049	.083	.0	.093	.078	.098	.049	.098	.0	.044	.044	.034	.0	.0
38	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.012	.012	.025	.039	.039
39	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.012	.012	.025	.039	.039
41	.029	.01	.0	.049	.083	.0	.093	.078	.098	.069	.098	.063	.039	.056	.060	.039	.039
42	.059	.088	.098	.049	.015	.098	.005	.02	.0	.0	.0	.0	.0	.025	.0	.0	.0
43	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.024	.012	.025	.039	.039
44	.069	.088	.098	.049	.015	.098	.005	.02	.0	.02	.0	.039	.024	.036	.025	.039	.039
45	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
46	.059	.088	.098	.049	.015	.098	.005	.02	.0	.0	.0	.0	.0	.025	.0	.0	.0
47	.02	.01	.0	.049	.083	.0	.093	.078	.098	.049	.098	.0	.039	.044	.034	.0	.0
48	.01	.0	.0	.0	.0	.0	.0	.0	.0	.02	.0	.039	.024	.012	.025	.039	.039
49	.039	.0	.0	.0	.0	.0	.0	.0	.0	.078	.0	.157	.094	.047	.102	.157	.157
50	.127	.029	.0	.147	.250	.0	.279	.235	.294	.284	.294	.274	.282	.185	.281	.274	.274

Table 1 --continued

STORM #4

Intervals (15min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
51	.167	.108	.098	.147	.181	.098	.191	.176	.196	.250	.196	.364	.261	.204	.266	.304	.304
52	.059	.0	.0	.0	.0	.0	.0	.0	.0	.118	.0	.024	.141	.070	.153	.235	.235
53	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
54	.108	.176	.196	.098	.629	.196	.010	.039	.0	.0	.0	.0	.0	.088	.0	.0	.0
55	.167	.265	.294	.147	.044	.294	.015	.059	.0	.0	.0	.0	.0	.132	.0	.0	.0
56	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
57	.059	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
58	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
59	.029	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
60	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
61	.029	.0	.0	.0	.0	.0	.0	.0	.0	.059	.0	.118	.070	.035	.076	.118	.118
62	.039	.010	.0	.049	.083	.0	.093	.078	.098	.088	.096	.078	.086	.067	.085	.078	.078
63	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
64	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
65	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
66	.059	.088	.098	.049	.015	.098	.005	.020	.0	.0	.0	.0	.0	.025	.0	.0	.0
67	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
68	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
69	.059	.088	.098	.049	.015	.098	.005	.020	.0	.0	.0	.0	.0	.025	.0	.0	.0
70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
71	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
72	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
73	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
74	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
75	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
76	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
77	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
78	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
79	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
80	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
81	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
82	.078	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.0	.039	.069	.034	.0	.0
83	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
84	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
85	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
86	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
87	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
88	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
89	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
90	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
91	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
92	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
93	.020	.010	.0	.049	.083	.0	.093	.078	.098	.0	.088	.0	.039	.056	.034	.0	.0
94	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
95	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
96	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
97	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
98	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
99	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
100	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.411	2274	2.352	1.960	1.544	2.352	1.607	1.548	1.568	2.288	1.568	2.891	2.189	2.171	2.427	2.891	2.891

Table 1 --continued

STORM # 5

Intervals (15min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
13	.020	.0	.0	.0	.0	.0	.0	.0	.0	.049	.0	.098	.059	.029	.064	.098	.098
14	.020	.01	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
15	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
18	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
19	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
21	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
28	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
29	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
31	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
33	.0	.0	.0	.0	.0	.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
34	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
35	.039	.010	.0	.049	.0	.0	.0	.0	.0	.049	.0	.098	.059	.074	.064	.098	.098
36	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
37	.020	.0	.0	.0	.0	.0	.0	.0	.0	.049	.0	.098	.059	.029	.064	.098	.098
38	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
39	.020	.010	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
40	.078	.088	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098
41	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.024	.0	.0	.0
42	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.029	.034	.0	.0
43	.098	.098	.078	.098	.049	.049	.049	.049	.098	.098	.098	.098	.098	.098	.098	.098	.098
44	.078	.088	.098	.049	.015	.049	.005	.020	.0	.098	.0	.098	.059	.074	.064	.098	.098
45	.078	.048	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
46	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
47	.127	.187	.196	.147	.113	.196	.103	.118	.098	.098	.098	.0	.039	.093	.034	.0	.0
48	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
49	.039	.098	.0	.049	.083	.0	.093	.078	.098	.049	.098	.098	.098	.074	.098	.098	.098
50	.078	.088	.098	.049	.015	.098	.005	.020	.0	.098	.0	.098	.059	.054	.064	.098	.098

Table 1 --continued

STORM #

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
51	.020	.010	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
52	.020	.0	.0	.0	.0	.0	.0	.0	.0	.049	.0	.098	.059	.029	.064	.098	.098
53	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
54	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
55	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
56	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
57	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
58	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
59	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.098	.039	.069	.034	.0	.0
60	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
61	.078	.088	.098	.049	.015	.098	.005	.020	.0	.098	.0	.0	.059	.054	.064	.098	.098
62	.020	.010	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.39	.044	.034	.0	.0
63	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.098	.0	.025	.0	.0	.0
64	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
65	.078	.088	.098	.049	.015	.098	.005	.020	.0	.098	.0	.0	.059	.054	.064	.098	.098
66	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
67	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.098	.039	.069	.034	.0	.0
68	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
69	.078	.088	.098	.049	.015	.098	.005	.020	.0	.098	.0	.0	.059	.054	.064	.098	.098
70	.020	.010	.0	.049	.083	.0	.093	.078	.098	.0	.098	.098	.039	.064	.034	.0	.0
71	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
72	.078	.088	.098	.049	.015	.098	.005	.020	.0	.098	.0	.0	.059	.054	.064	.098	.098
73	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
74	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
75	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
76	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
77	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
78	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
79	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
80	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.558	3.009	3.136	2.499	2.058	3.136	1.833	2.019	1.764	2.352	1.764	1.568	1.646	1.950	1.568	1.568	1.568

Table 1 --continued

STORM # 7

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
4	.020	.010	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
14	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
15	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
17	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
18	.069	.088	.098	.049	.015	.098	.005	.020	.0	.069	.0	.039	.024	.036	.025	.039	.039
19	.137	.186	.196	.147	.113	.196	.103	.118	.098	.118	.098	.039	.027	.103	.060	.039	.039
20	.137	.176	.196	.098	.029	.196	.098	.039	.0	.157	.0	.118	.070	.083	.076	.118	.118
21	.137	.108	.098	.147	.181	.098	.181	.176	.196	.157	.196	.196	.196	.172	.196	.157	.157
22	.039	.0	.0	.0	.0	.0	.0	.0	.0	.078	.0	.157	.094	.047	.102	.196	.196
23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
24	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
27	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
28	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
29	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
30	.020	.010	.0	.049	.083	0	.093	.078	.098	.0	.098	.0	.039	.044	.034	.0	.0
31	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.39
32	.059	.010	.098	.049	.005	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
33	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
34	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
35	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
36	.020	.010	.0	.049	.083	.0	.093	.078	.098	.0	.098	.0	.0	.044	.034	.0	.0
37	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
38	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
39	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40	.059	.088	.098	.049	.015	.098	.005	.020	.0	.049	.0	.0	.0	.025	.0	.0	.0
41	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
42	.010	.0	.0	.0	.0	.0	.0	.0	.0	.020	.0	.039	.024	.012	.025	.039	.039
43	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
44	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
45	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
46	.078	.098	.098	.098	.098	.098	.098	.098	.098	.049	.098	.0	.039	.069	.034	.0	.0
47	.069	.088	.098	.049	.015	.098	.005	.020	.0	.069	.0	.039	.024	.036	.025	.039	.039
48	.049	.010	.0	.049	.083	.0	.093	.078	.098	.059	.098	.118	.110	.079	.111	.110	.110
49	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
50	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Table 1 --continued

STORM # 1

Intervals (15 min)	Basin Average Rainfall (in.)	Subarea Rainfall Distribution (in.)															
		A		B		H		I		J		L		M		N	
		THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO	THE	ISO
51 52	.069 .020	.088 .010	.098 .0	.049 .049	.015 .083	.098 .0	.005 .093	.020 .678	.0 .098	.069 .0	.0 .098	.039 .0	.024 .039	.036 .044	.025 .034	.039 .0	.039 .0
53 54	.010 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.039 .0	.024 .0	.012 .0	.025 .0	.039 .0	.039 .0
55 56	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0	.0 .0
57 58	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
59 60	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
61 62	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
63 64	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
65 66	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
67 68	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
69 70	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
71 72	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
TOTAL	1.313	1.323	1.372	1.127	0.955	1.372	0.882	0.98	0.882	1.176	0.882	0.98	0.866	0.97	0.946	0.98	0.98

comparing Runs 38 with 39, 40 with 41, through Runs 74 with 75. The Theissen method was used in the final runs. Table 1 compares the rainfall amounts based on basin average, Theissen and isohyetal methods for Storms 1, 2, 4, 5 and 7. The area percentages covered by each of the three rainfall gaging stations for both the Theissen and isohyetal methods are given in Table 2.

The many parameters required for HEC-1 are listed in Appendix A. Starting with Run 9, the seven subareas B through H were divided into pervious and impervious parts. This approach allowed different parameters values to be prescribed for the pervious and impervious parts of each subarea, providing more accurate simulations.

Streamflow data for both Stations #21 and #51 were read in only to enable the "observed" hydrographs to be plotted and compared with the computed ones.

The hydrograph for the whole basin was generated by the following procedure: (1) generate the hydrographs for the pervious part and impervious part of the most upstream subarea, (2) add the two hydrographs and then route (by the Modified Puls method, described later) the result through the subarea, to form the outflow hydrogragh for this specific subarea, (3) route the hydrograph along the creek channel using the Muskingum method (discussed in a later section) to reach the catch point, and (4) if there are any other hydrograghs also reaching that catch point, add them together to form the multi-subarea hydrograph for the total area upstream of that catch point. Repeat these four procedures until the last

Table 2 THE SUBAREA CHARACTERISTICS

Sub-areas	Square miles	Pervious %	Theissen method: % covered by stations			isohyetal method: % covered by stations		
			1	36	125	1	36	125
A	2.98	85	–	88	12	–	100	-
B	1.08	65	–	50	50	–	15	85
H	2.06	68	–	100	–	–	5	95
I	0.95	45	–	20	80	–	–	100
J	0.41	45	50	50	–	–	–	100
L	0.58	45	100	–	–	60	–	40
M	0.95	45	30	25	45	65	-	35
N	0.76	45	100	–	–	100	–	–

catch point is reached. Since this is the position of Gaging Station #51 and the outlet point of the whole basin, we thus obtain the outflow hydrograph for the whole basin.

There are eighty four selected computer outputs in Appendix B which display the hydrograph comparisons and their data for different approaches. Each "run" was numbered for easy later reference.

COMPUTER PROGRAM HEC-1

The HEC-1 model developed by the Hyrologic Engineering Center of the Army Corps of Engineers is designed to simulate the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. The HEC-1 program used was the 1981 version, which has completely revised input and output formats (see the 1981 HEC-1 User's Manual[2]). HEC-1 has some limitations, the major one being that simulation is limited to a single storm due to the fact that provision is not made for soil moisture recovery during periods of no precipitation. The storms tested in this study, presumably because of this limitation and the possibly already-saturated soil, yielded less than satisfactory predictions.

No modification was made to the HEC-1 program other than to the input/output code, which was changed to suit Santa Clara University's DEC-2060 system. Three program functions were employed in this study: (1) unit hydrograph and loss rate parameter optimization, (2) watershed unit hydrograph generation, and (3) comparison between computed and observed hydrographs.

The program has different options for output formats. Because of its huge size, complete output is not included in the appendices of this report. The input file of the last run is included in Appendix B.

OPTIMIZATION

The optimization function of HEC-1 provides a set of optimized parameters based on observed rainfall and runoff records. The parameters optimized in the study were the time of concentration Tc, routing coefficient R and the loss rate parameters STRKR, DLTKR, and RTIOL. The optimization results are shown in Runs 1 and 2 of Appendix B.

Because there are eight subareas in the whole basin, the optimization results yield "lumped" or averaged parameters which can only serve as guideline for calibrating the subarea parameters. Although the error of the sum of flows and the average absolute percentage error were low, this doesn't mean that we can apply the optimized parameters directly to represent all the subareas. Adjustment based on our knowledge of the characteristics of each subarea was required in order to achieve more realistic model parameters. This adjustment procedure is discussed later under Parameter Adjustment and Reconstitution.

SUBAREA DELINEATION AND HYDROGRAPH GENERATION

The reason for dividing the watershed into subareas was to facilitate a more detailed representation of the basin's physical characteristics. Each subarea should be an individual area with no flows across boundaries except at the outlet. For the Ross Creek watershed, larger storms sometimes fill up the stormdrain system and runoff then travels in the gutters, sometimes in different directions from the storm drains. As a result, the subarea boundaries are changed for an uncertain time and for an uncertain fraction of the runoff. These dynamic or moving boundaries, although occurring, were not treated as an important factor. This phenomenon may explain why simulations sometimes did not closely match the observed record.

Stormdrain maps from the City of San Jose and the Town of Los Gatos were examined. We found that the original subarea map provided by the SCVWD (see Fig. 1) had some boundaries which did not agree with the subareas defined by the storm drains. Early studies of ways to model drainage area characteristics included the following two approaches: (1) based on stormdrain system maps, further divide the subareas so that no storm water flows across the boundaries, and (2) a micro-area approach, which treats each home lot as an individual area, and in which other land uses such as parks and schools also generate individual hydrographs. Ideally, all the individual hydrographs in the basin can be added up to generate the basin hydrograph with the help of routing procedures (discussed later).

We had to abandon our efforts on these two tedious approaches because of their heavy time and manpower needs. However, Approach (1) is recommended for further study in the Ross Creek area because there have been some changes such as blocking off pipes and new construction in the area during the last decade, although we found the original map (Fig. 1) to be generally correct. The only change we made was to eliminate the area downstream of gaging station #51.

The subareas were divided into pervious and impervious parts, because parameters such as Tc, R, the loss rate parameters, and constants such as baseflow and area differ considerably between these two components of a single subarea, but are similiar to their respective parts of other subareas. This provides a more reasonable approach to hydrograph generation. The representation of separate pervious/impervious parts also has the advantages that we can describe the subarea more precisely and we can clearly define the impervious fraction of a specific subarea. Note that the parameter RTIMP, ratio of imperviousness, should not be used under such an approach however, or this will result in a double-accounting for impervious areas.

ROUTING METHODS

Flows in the main creek channel were routed using the Muskingum method. The creek was divided into five reaches, defined by collection points 1 through 6 (where point 6 was taken to be at Station #51) shown on Fig. 1. Thus the flows which entered the upper collection point were routed through the reach to the lower collection point, where inflows from other sources could be added in to obtain the input for the next reach. The value of Muskingum's K is approximately equal to the flow travel time through the reach. The average flow velocity used to allocate K values was 4.5 fps. Muskingum's X is a weighting factor lying between 0 and 1, and the following relationship between K and X should be satisfied:

$$\frac{1}{(1 - X)} \leq \frac{K * 120}{\Delta t} \leq \frac{1}{X}$$

where Δx is routing period, has same unit as K

The X value was assumed to be 0.1 as recommended in the previous study[1]. A value of 0.3 was tested (see Run 21), but this change was found to have negligible effect on the hydrograph.

Flows through the stormdrain systems were routed using the Modified Puls routing method. It detained the water volumes and so flattened the peaks of the hydrographs. We applied the Modified Puls routing to the whole basin, to subareas B through N, and to subareas I through N only (see Runs 3 to 8). The shapes of the resulting hydrographs showed that the larger the area covered by Modified Puls routing, the flatter was the hydrograph generated.

The storage-discharge relationship used for the Modified Puls routing method was taken from previous work[1]. This relationship was changed several times to experiment on its impact on the hydrographs. Eighty percent and fifty percent of the storage in the original storage/discharge relationship were tried. These reduced the water volumes stored as expected, but the original relationship was used in the latest runs because it produced a more accurate hydrograph. However, this relationship should be adjusted to reflect the updated storage-discharge curves presently being developed by SCVWD. This we felt will directly affect the hydrograph, which is worth exploring, because of the sensitive reaction from the different relationships. More study of this is recommended.

RAINFALL DISTRIBUTION

The distribution of rainfall within a storm was found to affect the hydrograph only slightly. Three types of precipitation distribution have been tested. Basin average rainfall used the same rainfall over the whole basin, while the Theissen and Isohyetal methods yielded different rainfalls over each subarea. For storms #1 and #2, the subarea Isohyetal method gave the best prediction, followed by the subarea Theissen method and lastly the basin average rainfall. There was a difference of about 2% between the basin average and the Theissen methods, and about 12% difference between the Isohyetal and the Theissen methods in average absolute percentage errors. Both the Theissen and the Isohyetal methods were tested for Storms #4, #5 and #7 in Runs 38 through 43. Table 3 shows the difference between Theissen and isohyetal rainfall distributions on subareas for the storms #1, #2, #4, #5, and #7.

Table 3 ACCUMULATED RAINFALL OF STORMS #1, #2, #4, #5 and #7

Subarea / storm	A		B		H		I		J		L		M		N	
	TH_E	IS_O	TH_E	IS_O	TH_E	IS_O	TH_E	IS_O	TH_E	IS_O	TH_E	IS_O	TH_E	IS_O	TH_E	IS_O
1	3.06	3.53	2.70	2.25	3.33	2.12	2.31	2.06	2.79	2.06	2.22	2.22	2.41	2.22	2.22	2.22
2	3.21	3.48	3.04	2.70	3.43	2.50	2.65	2.55	3.14	2.55	2.55	2.55	2.90	2.52	2.55	2.55
4	2.20	2.35	1.96	1.88	2.35	1.61	1.72	1.57	2.29	1.57	2.89	2.32	2.25	2.67	2.89	2.39
5	3.01	3.14	2.50	2.06	3.14	1.83	2.02	1.76	2.35	1.76	1.57	1.65	1.95	1.57	1.57	1.57
7	1.32	1.57	1.13	0.96	1.37	0.93	0.98	0.88	1.07	0.83	0.98	0.87	1.03	0.95	0.98	0.98

Table 4 THE OBSERVED LOSS RATE OF BASIN AVERAGE RAINFALL

STORMS	Basin Average Rainfall (in)	Observed equivalent depth (in)	Loss (%)
1	2.851	1.085	62
2	3.12	1.297	60
4	2.46	0.423	82
5	2.56	0.771	70
7	1.24	0.305	75

PARAMETER ADJUSTMENT AND RECONSTITUTION

The optimization procedure decribed earlier yielded "lumped" or average parameters for the entire basin. From our knowledge of the physical characteristics of the basin, it was clear that most of these parameters should vary from area to area within the basin. The objective of parameter adjustment was to identify for each subarea parameter values, usually different, which were more realistic and which together generated improved, reconstituted outflow hydrographs. This process of identifying improved parameter values is referred to as calibration.

Subarea parameters which had the most significant effects on reducing the error in the calibration were found to be (1) RTIOR, which defined the recession rate of the subarea baseflow, (2) STRKR, which defined the starting loss rate of a subarea, and (3) DLTKR, which defined the accumulated loss while the loss rate kept increasing.

RTIOR adjusted the shape of the recession curves which enabled the calculated curves to match well with the observed curve (Run 17). But for a different storm, it produced too fast a recession (see Run 40). STRKR and DLTKR control the total hydrograph volume and affect the accuracy of the hydrograph reproduction a lot. According to the characteristics of the impervious and pervious surface, we have used higher loss rate parameters for the impervious part than the pervious part. This approach helped the computed hydrograph curves match the observed curves fairly well. In Run 22, we further reduced both parameters for the pervious part to very small amounts, and then the second hydrograph peak appeared. This suggests that the sensitivity of the simulation response improved.

The other parameters changed were Tc and R of Clarke's unit hydrograph. A set of Tc and R values was obtained by trial and error. We then obtained a second set by hyrograph analysis of the observed hydrographs for storms #1 and #2, and saw no significant improvements in hydrograph reproduction (Runs 34, 34-1, 35 and 35-1). We also conducted a sensitivity test for the routing coefficient R with a 300% change and obtained undesirable results (Runs 11 and 12). This suggests that we don't expect Tc or R to have beneficial influences and that the values used for them are in reasonable ranges.

The parameter adjustment tests were made with five storms: #1, #2, #4, #5 and #7. These represented different rainfall and runoff situatuions. Storms #9 and #10 were impossible to test properly because they lacked rainfall records at Station 1, which affected the Theissen and isohyetal rainfall distributions over the subareas. Storms #1 and #2 are similiar, so the parameters were calibrated around these two storms, for which the final accuracies of reproduction were (see Run 32 and 33):

	Storm #1	Storm #2
Sum of Flows:	-3.07%	-6.17%
Standard Error:	224	150
Ave. % Abs. Error:	49.97%	42.45%

After developing the best set of parameters, we tested them unchanged on Storms #4, #5 and #7. Storm #4 had a fairly even distribution of rainfall, in Storm #7 the rainfall intensities rose to a sharp peak, and Storm #5 fell between the extremes of Storms #7 and #4. The results (Runs 39, 41 and 43) were:

	Storm #4	Storm #5	Storm #7
Sum of Flows:	144.04%	-0.70%	119.60%
Standard Error:	263	125	210
Ave. % Abs. Error:	236.67%	150.62%	268.65%

These results suggest that, at this point, we can only satisfactorily apply the parameter set to storms similiar to Storm #1 with short, intense periods of rainfall. Storm #5 showed a better reproduction than both Storms #4 and #7 because it is more similiar to Storms #1 and #2 than the other two storms. Storms #3, #4 and #8, belonging to the "distributed" rainfall group, should be calibrated and tested together separately. It seems that we might need two or even more different parameter sets for the basin for the different storm types. In runs starting with Run 44, the adjustment and improvement were made mostly by changing parameters STRKR, DLTKR and Tc. It was evident that we should match the computed and observed total volumes before we considered the shape differences. In Runs 44 to 53, we adjusted STRKR and DLTKR by increasing them slightly, and expected a lower total volume on the computed hydro-graph because of the higher loss rate. The results, as expected, gave lower average absolute errors. DLTKR, as the manual described, should be storm dependent. In later runs (Runs 76 to 84), it was set at a higher value to obtain better comparisons between the equivalent depth of the computed and observed hydrographs (see Table 4) because there was still insufficient loss indicated. We used this comparison as a guideline to adjust the loss rate parameters. Although we changed DLTKR from storm independent to storm dependent in later runs, this did not help much to reduce the errors. This may be seen by comparing Runs 44 with 54, 45 with 55, 46 with 56, through Runs 53 with 63. The results were almost the same.

Reducing the delay in time to peak was always the goal after we obtained a low volume difference between the observed and computed hydrographs. This delay time has always been a significant problem. We were never able to get the computed hydrographs to respond fast enough to match the rising curve of the observed hydrograpghs. The peak lag caused by this response delay was in the range of 0.75 to 1.5 hours, depending on the storm. In Runs 36 and 37 we reduced STRKR for each subarea in the hopes of achieving faster rising curves but without success. In Runs 64 to 69 we reduced the value of STRKR even more and increased DLTKR to compensate for the overall loss. This adjustment was based on the expectation that the reduced initial loss rate would cause the computed hydrograph to rise faster and that we could meawhile maintain the total volume about the same by adjusting DLTKR simultaneously. Reducing STRKR by 50% and increasing DLTKR by 100% caused the average absolute error to increase by about 100% for the subarea Theissen rainfall distributions of Storms #1 and #2 and to increase by about 50% for subarea isohyetal rainfall distributions, but gave less error on Storm #5. The computed hydrograph peak time was still delayed without any significant change.

In Runs 70 to 75, we reduced Tc by 50% and expected to see some peak shifting. Although Tc was then very small, this shifted the peak by only about 0.25 hr. = 15 minutes.

In order to check the Tc obtained by trial and error, we then used the Kirby-Hathaway equation to calculate the Tc for each subarea by specifying the average travelling length and the Manning's n -values and slopes as shown in Table 5. In addition, as mentioned before, DLTKR also was increased in Runs 76 to 84. The results showed slight improvement. Runs 77, 80 and 83 compared computed and observed hydrographs for subarea A only. These suggested that our estimation of loss rates might be too high, because the volumes are significantly less than the observed volumes for subarea A. We then used the observed hydrograph at Gaging Station #21 and continued the modelling downstream to Station #51. The results (Runs 78, 81 and 84) showed good improvements in both the time to the peak and in the volume of the computed hydrograph (30% increase).

CONCLUSIONS

Differences between the volumes of observed and computed hydrgraphs may actually be legitimate because of some doubtful flowrate records at Station #51. (These doubtful records were noticed at the end of this study when comparing flows at Stations #21 and #51.) For example, in Run 78 we have a percentage error on the sum of flows as 37.21%, in Run 81 it is 32.61%, and Run 84 has 37.32% after we got the best parameter sets. This means we could allow about a 30% overestimation of the flows at Station #51 while

Table 5. THE Tc COMPARISON, where: Tc_1= Kirby-Hathaway;
Tc_2= Graphic Analysis;
Tc_3= previous best set from trial & error

Subarea	L_f (ft)	n	S_f (ft/ft)	Tc_1	Tc_2	Tc_3
A	8195.12	0.058	0.03417	0.55	0.5	0.65
B_I	7609.76	0.016	0.00961	0.39	0.24	0.35
B_p	7609.76	0.065	0.00961	0.76	0.48	0.55
H_I	7609.76	0.016	0.02904	0.30	0.35	0.42
H_p	7609.76	0.065	0.02904	0.58	0.70	0.64
I_I	9365.85	0.016	0.00854	0.44	0.45	0.45
I_p	9365.85	0.042	0.00854	0.70	0.90	0.55
J_I	4682.93	0.016	0.01403	0.29	0.18	0.25
J_p	4682.93	0.042	0.01403	0.45	0.36	0.40
L_I	5853.66	0.016	0.01093	0.34	0.23	0.30
L_p	5853.66	0.042	0.01093	0.53	0.46	0.40
M_I	7024.39	0.016	0.00569	0.43	0.27	0.35
M_p	7024.39	0.042	0.00569	0.67	0.54	0.51
N_I	5628.29	0.016	0.00854	0.35	0.25	0.35
N_p	5628.29	0.042	0.00854	0.55	0.50	0.48

we adjust other parameters. We also conclude that the stubborn nature of the peak lag problem suggests that the observed data may not have been synchronous.

We hope that the efforts made on this study and the discussions held will be helpful for future research and development in the field of urban hydrology simulation. It is clearly a very complicated system and there still are many problems needing further study.

RECOMMENDATION

The testing and adjusting procedures performed and results obtained in this study lead to the following recommendations:

(1) Manning's n needs more careful adjustment because it showed an important effect on determining Tc;

(2) parameter DLTKR plays an important part both in volume adjustment and in the average absolute errors. Because there is no clear definition for DLTKR and a lack of guidelines, more study is needed in order to find a better approach to adjust it;

(3) the storage-discharge relationship directly controls the volume and the shape of a hydrograph. Some improvements to the old data should be made to reflect subsequent changes in the stormdrain system in the urban area, which should improve simulation.

(4) further divide the subarea so that there are no storm flows and drainage accross the subarea boundaries.

REFERENCES

1. Saah, A.D., and E. Watson, "Santa Clara Valley Water District Urban Hydrology Methodology," paper presented at the National Synposium on Urban Hydrology and Sediment Transport, Lexington, Kentucky, July 1976.
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Appendix A

The Effect on Ave. Abs. % Error by changing Impervious Percentage ; Running Optimization ; no routing ; storm #1 ;

BA 9.96 (on the whole basin)
BF 22 -.2 1.4
LE -1 -1 -1 .3
UC -1 -1

Impervious %	Tc	R	STRKR	DLTKR	RTIOL	Ave. Abs. % Error	
0	0.26	1.43	0.36	0.16	1.0	33.92	
5	0.26	1.39	0.38	0.18	1.0	32.52	
10	0.26	1.19	0.40	0.57	1.0	33.59	
15	0.26	1.15	0.43	0.56	1.0	34.68	
20	0.26	1.13	0.48	0.75	1.0	34.62	
25	0.26	1.14	0.57	0.76	1.49	33.70	
30	0.26	1.14	0.65	0.74	1.0	31.90	
35	0.26	1.17	1.10	2.38	2.0	32.23	
40	0.26	1.58	1.79	4.48	2.0	36.75	
45	0.26	2.16	1.79	4.48	2.0	51.08	
50	0.26	2.80	1.79	4.48	2.0	72.80	
55	0.26	3.62	1.79	4.48	2.0	113.78	
60	0.26	4.65	1.79	4.48	2.0	164.95	
65	0.26	5.80	1.79	4.48	2.0	211.94	
70	0.26	7.07	1.79	4.48	2.0	251.83	
75	0.27	8.44	1.79	4.48	2.0	283.40	
80	0.28	10.05	1.79	4.48	2.0	307.21	
85	0.29	11.60	1.79	4.48	2.0	324.03	
90	0.30	13.16	1.79	4.48	2.0	336.30	
95	0.31	14.92	1.79	4.48	2.0	343.88	
100	0.33	16.57	0.24	0.6	2.0	349.68	

Tc , R, STRKR, DLTKR and RTIOL are the optimized parameters; where the average impervious percentage should be between 30~35% or 25%~40% for the acceptable guidline from optimization.

The Effect of Impervious % ; on subarea A only.

BA 2.86
BF 8 -.3 1.3
LE -1 -1 -1 .3 ___
UC -1 -1

Imp. %	T_c	R	STRKR	DLTKR	RTIOL	Error
0	0.26	0.54	0.23	0.57	1.0	43.03
5	0.26	0.54	0.25	0.60	1.0	42.81
10	0.26	0.54	0.26	0.63	1.0	42.18
15	0.27	0.54	0.28	0.65	1.0	41.65
20	0.27	0.54	0.30	0.69	1.0	41.31
25	0.27	0.54	0.32	0.75	1.0	41.98
30	0.27	0.54	0.34	0.76	1.0	42.82
35	0.27	0.54	0.37	0.83	1.0	43.29
40	0.29	0.54	0.41	0.78	1.0	45.14

With data set as Imp % = 20%. ERAIN = 0.25
⇒ 0.27 0.54 0.28 0.66 1.0 40.71

With data set as Imp % = 20% ERAIN = 0.20
⇒ 0.28 0.53 0.27 0.64 1.0 39.98

With data set as Imp % = 20% ERAIN = 0.15
⇒ 0.28 0.54 0.26 0.62 1.0 39.10

The adjustments on ERAIN

→ For station #21 only:

The data set used:

① BA 2.5
BF 8 −.3 1.3
LE .23 .90 1.28 $\underline{\underline{.35}}$ 15
UC .26 .51

⇒ Ave. Abs. % error = 47.03 %

② Changed ERAIN only:
LE .23 .90 1.28 $\underline{\underline{.25}}$ 15

⇒ Ave. Abs. % error = 40.73 %

③ Changed Tc so that
UC .56 .51

⇒ Ave. Abs. % error = 34.55 %

④ changed ERAIN again:
LE .23 .90 1.28 $\underline{\underline{.15}}$ 15

⇒ Ave. Abs % error = 32.77 %

T_c & R Adjustments =

For Storm #1; Complete Initial Input data enclosed; Theissen isohyetal rainfalls;

area	T_c and R	T_c and R	T_c and R	T_c and R	T_c and R
A	T_c = 0.65 R = 1.24	T_c = 0.65 R = 3.72	T_c = 0.65 R = 0.41	T_c = 0.45 R = 1.24	T_c = 0.45 R = 0.41
B_I	T_c = 0.35 R = 0.56	T_c = 0.35 R = 1.68	T_c = 0.35 R = 0.18	T_c = 0.2 R = 0.56	T_c = 0.2 R = 0.18
B_p	T_c = 0.55 R = 0.92	T_c = 0.55 R = 2.76	T_c = 0.55 R = 0.31	T_c = 0.42 R = 0.92	T_c = 0.42 R = 0.31
H_I	T_c = 0.42 R = 0.66	T_c = 0.42 R = 1.98	T_c = 0.42 R = 0.22	T_c = 0.3 R = 0.66	T_c = 0.3 R = 0.22
H_p	T_c = 0.64 R = 1.04	T_c = 0.64 R = 3.12	T_c = 0.64 R = 0.35	T_c = 0.45 R = 1.04	T_c = 0.45 R = 0.35
I_I	T_c = 0.45 R = 0.65	T_c = 0.45 R = 1.95	T_c = 0.45 R = 0.22	T_c = 0.2 R = 0.65	T_c = 0.2 R = 0.22
I_p	T_c = 0.55 R = 0.92	T_c = 0.55 R = 2.76	T_c = 0.55 R = 0.31	T_c = 0.3 R = 0.92	T_c = 0.3 R = 0.31
J_I	T_c = 0.25 R = 0.52	T_c = 0.25 R = 1.56	T_c = 0.25 R = 0.17	T_c = 0.1 R = 0.52	T_c = 0.1 R = 0.17
J_p	T_c = 0.4 R = 0.68	T_c = 0.4 R = 2.04	T_c = 0.4 R = 0.23	T_c = 0.25 R = 0.68	T_c = 0.25 R = 0.23
L_I	T_c = 0.3 R = 0.54	T_c = 0.3 R = 1.62	T_c = 0.3 R = 0.18	T_c = 0.1 R = 0.54	T_c = 0.1 R = 0.18
L_p	T_c = 0.4 R = 0.7	T_c = 0.4 R = 2.1	T_c = 0.4 R = 0.23	T_c = 0.2 R = 0.7	T_c = 0.2 R = 0.23
M_I	T_c = 0.35 R = 0.6	T_c = 0.35 R = 1.8	T_c = 0.35 R = 0.2	T_c = 0.15 R = 0.6	T_c = 0.15 R = 0.2
M_p	T_c = 0.51 R = 0.83	T_c = 0.51 R = 2.49	T_c = 0.51 R = 0.28	T_c = 0.25 R = 0.83	T_c = 0.25 R = 0.28
N_I	T_c = 0.35 R = 0.58	T_c = 0.35 R = 1.74	T_c = 0.35 R = 0.19	T_c = 0.15 R = 0.58	T_c = 0.15 R = 0.19
N_p	T_c = 0.48 R = 0.85	T_c = 0.48 R = 2.55	T_c = 0.48 R = 0.28	T_c = 0.27 R = 0.85	T_c = 0.27 R = 0.28
standard = 307 Ave. Abs. % = 94.70		standard = 316 Ave. Abs. % = 96.14	standard = 339 Ave. Abs. % = 124.02	Ave. Abs. % = 92.91	Ave. Abs. % = 129.34

The best sets from previous experiments of T_c and R are:

A: $T_c = 0.65$ $R = 0.41$
B_I: $T_c = 0.35$ $R = 0.18$
B_P: $T_c = 0.55$ $R = 0.31$
H_I: $T_c = .42$ $R = 0.22$
H_P: $T_c = 0.64$ $R = 0.35$
I_I: $T_c = 0.45$ $R = 0.22$
I_P: $T_c = 0.55$ $R = 0.31$
J_I: $T_c = 0.25$ $R = 0.17$
J_P: $T_c = 0.4$ $R = 0.23$
L_I: $T_c = 0.3$ $R = 0.18$
L_P: $T_c = 0.4$ $R = 0.23$
M_I: $T_c = 0.35$ $R = 0.2$
M_P: $T_c = 0.51$ $R = 0.28$
N_I: $T_c = 0.35$ $R = 0.19$
N_P: $T_c = 0.48$ $R = 0.28$

Loss Rate Parameters Adjustments

With the Tc and R for each subarea, the loss rate parameters STRKR, DLTKR, ERAIN and RTIOR (of BF card) were changed.

See following pages for those changes and effect.

Area Param.	A	B_I	B_p	H_I	H_p	I_I	I_p	J_I	J_p	L_I	L_p	M_I	M_p	N_I	N_p
STRKR	0.68	0.2	0.5	0.2	0.5	0.3	0.35	0.25	0.4	0.25	0.35	0.25	0.35	0.25	0.35
DLTKR	1.2	0.4	0.85	0.43	0.9	0.42	0.65	0.35	0.55	0.32	0.5	0.4	0.47	0.36	0.5
RTIOR	?	2.5	4.3	2.2	4.0	2.2	4.0	2.4	4.0	2.5	4.3	2.7	4.2	2.2	4.2
Vol. % diff.						29.32%									
Ave. Abs. %					110.26%										
	6.5	3.5	7.5	3.5	7.5	3.5	7.5	3.5	7.5	3.5	7.5	3.5	7.5	3.5	7.5
Vol. %					0.09%										
Ave. Abs. %					60.38%										
X			all	X	changed		from	0.1 ⟶		0.3					
Vol. %					0.09%										
Ave. Abs. %					60.67%										
STRKR	0.68	0.03	0.5	0.03	0.5	0.02	0.35	0.02	0.4	0.02	0.35	0.02	0.35	0.02	0.35*
DLTKR	1.2	0.05	0.85	0.07	0.9	0.05	0.65	0.04	0.55	0.04	0.5	0.05	0.47	0.05	0.5
Vol. %					35.38%										
Ave. Abs. %					103.73%										
	0.68	0.03	0.8	0.03	0.8	0.02	0.6	0.02	0.6	0.02	0.6	0.02	0.6	0.02	0.6
	1.2	0.05	1.59	0.07	1.98	0.05	1.36	0.04	1.4	0.04	1.~~45~~ 32	0.05	1.~~32~~ 45	0.05	1.32
Vol. %					11.31%										
Ave. Abs. %				58.68%											
DLTKR	1.2	0.05	1.85	0.07	2.31	0.05	1.36	0.04	1.4	0.04	1.32	0.05	1.45	0.05	1.32
ERAIN	0.2	0.2	0.25	0.2	0.25	0.15	0.25	0.15	0.25	0.15	0.25	0.15	0.25	0.15	0.25
Vol. %				10.42%		←				?					→
Ave. Abs. %				57.93%											
STRKR	0.7	0.03	0.8	0.03	0.8	0.02	0.6	0.62	0.6	0.02	0.6	0.02	0.6	0.62	0.6
DLTKR	1.5	0.05	1.59	0.07	1.98	0.05	1.36	0.04	1.4	0.04	1.32	0.05	1.45	0.05	1.32
ERAIN	0.25	0.2	0.35	0.2	0.35	0.15	0.25	0.15	0.25	0.15	0.25	0.15	0.25	0.15	0.25
Vol. %				9.30%											
Ave. Abs. %			57.47%												
STRKR	0.8	0.03	1.0	0.03	1.0	0.02	0.6	0.02	0.6	0.02	0.6	0.02	0.6	0.02	0.6
Vol. %				2.17%											
Ave. Abs. %			52.34%												

* X_s switche back

Loss Rate parameters changes continued:

	A	BI	Bp	HI	Hp	II	Ip	JI	Jp	LI	Lp	MI	Mp	NI	Np
STRKR	0.6	0.03	0.7	0.03	0.7	0.02	0.5	0.02	0.4	0.02	0.4	0.02	0.5	0.02	0.5
DLTKR	1.3	0.05	1.36	0.07	1.51	0.05	0.96	0.04	0.75	0.04	0.8	0.05	0.95	0.05	0.92
RTIOR	5.5	6.5	3.5	6.5	3.5	6.5	3.5	6.5	3.5	6.5	3.5	6.5	3.5	6.5	3.5
Vol. %					−3.07%				(This is with isohyetal method)						
Ave.Abs.%					49.97%										
Tc	0.5	0.24	0.48	0.35	0.70	0.45	0.90	0.18	0.36	0.23	0.46	0.27	0.54	0.25	0.50
Vol. %					−6.93%										
Ave.Abs.%					52.68%										

up to this point, applied the data set on other storms:

	THEISSEN	ISOHYETAL
STORM#1		
Vol. %	13.1%	−6.93%
Ave.Abs.%	67.95%	52.68%
STORM#2		
Vol %	12.94%	−10.00%
Ave.Abs.%	62.11%	42.53%
STORM#4		
Vol. %	153.02%	144.04%
Ave.Abs.%	262.84%	236.67%
STORM#5		
Vol %	19.46%	−0.7%
Ave.Abs.%	197.01%	150.62%
STORM#7		
Vol. %	64.25%	119.60%
Ave.Abs.%	146.54%	268.65%

Still, storm#1, #2, #4, #5, #7 conducted further change.

	A	B_I	B_P	H_I	H_P	I_I	I_P	J_I	J_P	L_I	L_P	M_I	M_P	N_I	N_P
STRKR	0.6	0.03	0.8	0.03	0.8	0.02	0.6	0.02	0.5	0.02	0.5	0.02	0.5	0.02	0.5
DLTKR	1.4	0.05	1.6	0.07	1.6	0.05	1.2	0.04	1.0	0.04	1.0	0.05	1.0	0.05	1.0
Vol. %		storm#1 THE: 7.97% ISO: -5.23%													
Ave.Abs.%		storm #1 THE: 60.87% ISO: 49.19%													
Vol %		Storm#2 THE: 8.51% ISO: -8.57%													
Ave.Abs.%		storm#2 THE 55.79% ISO 40.07%													
Vol. %		storm#4 THE: 147.12% ISO: ~~255.00%~~ 137.04%													
Ave Abs.%		storm#4 THE: 255.00% ISO: 227.24%													
Vol. %		storm#5 THE: 16.60% ISO: -2.39%													
Ave.%		storm#5 THE: 195.52% ISO: 149.76%													
Vol.%		storm#7 THE: 59.53% ISO: 45.46%													
Ave.%.		storm#7 THE: 142.45% ISO: 138.57%													

starting to use storm dependent DLTKR:

DLTKR	2.0	0.05	1.17	0.07	1.10	0.05	0.88	0.04	0.88	0.04	0.95	0.05	0.95	0.05	0.95

STORM#1, THEISSEN: Vol.% = 7.28%; Ave.ABS.% = 61.11%

DLTKR	2.06	0.05	1.42	0.07	1.31	0.05	1.10	0.04	1.10	0.04	1.10	0.05	1.08	0.05	1.10

STORM#2, THEISSEN: Vol.% = 7.20%; Ave.ASS. % = 56.71%

DLTKR	1.42	0.05	0.96	0.07	0.81	0.05	0.66	0.04	0.66	0.04	1.00	0.05	1.15	0.05	1.25

STORM#4, THEISSEN: Vol.% = 147.29%; Ave.Abs.% = 255.16%

DLTKR	1.99	0.05	1.06	0.07	0.96	0.05	0.74	0.04	0.74	0.04	0.69	0.05	0.66	0.05	0.66

STORM#5, THEISSEN: Vol.% = 16.49%; Ave.Abs.% = 195.44%

DLTKR	0.82	0.05	0.46	0.07	0.42	0.05	0.35	0.04	0.35	0.04	0.32	0.05	0.38	0.05	.39

STORM#7, THEISSEN: Vol.% = 69.66%; Ave.ASS.% = 149.49%

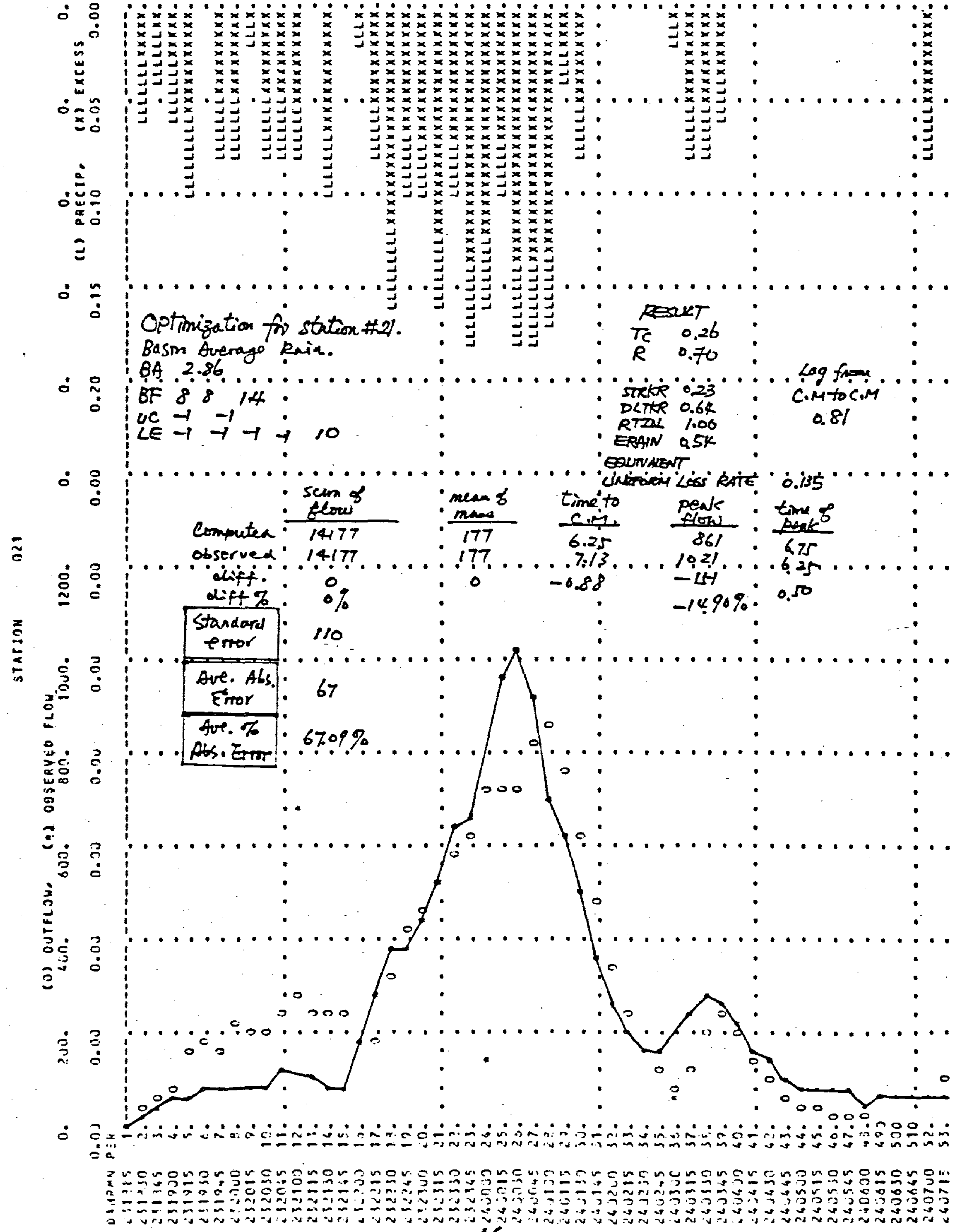
By Reducing all STRKR by 50%, Increase DLTKR by 100% (perviousparts only)

STORM#1, THEISSEN: Vol.% = 32.75%; Ave.ASS.% = 120.47%

all other storms also have increased errors.

Appendix B

RUN 1 P1



Optimization for station #21.
Basin Average Rain.
BA 2.86
BF 8 8 14
UC -1 -1
LE -1 -1 -1 -1 10

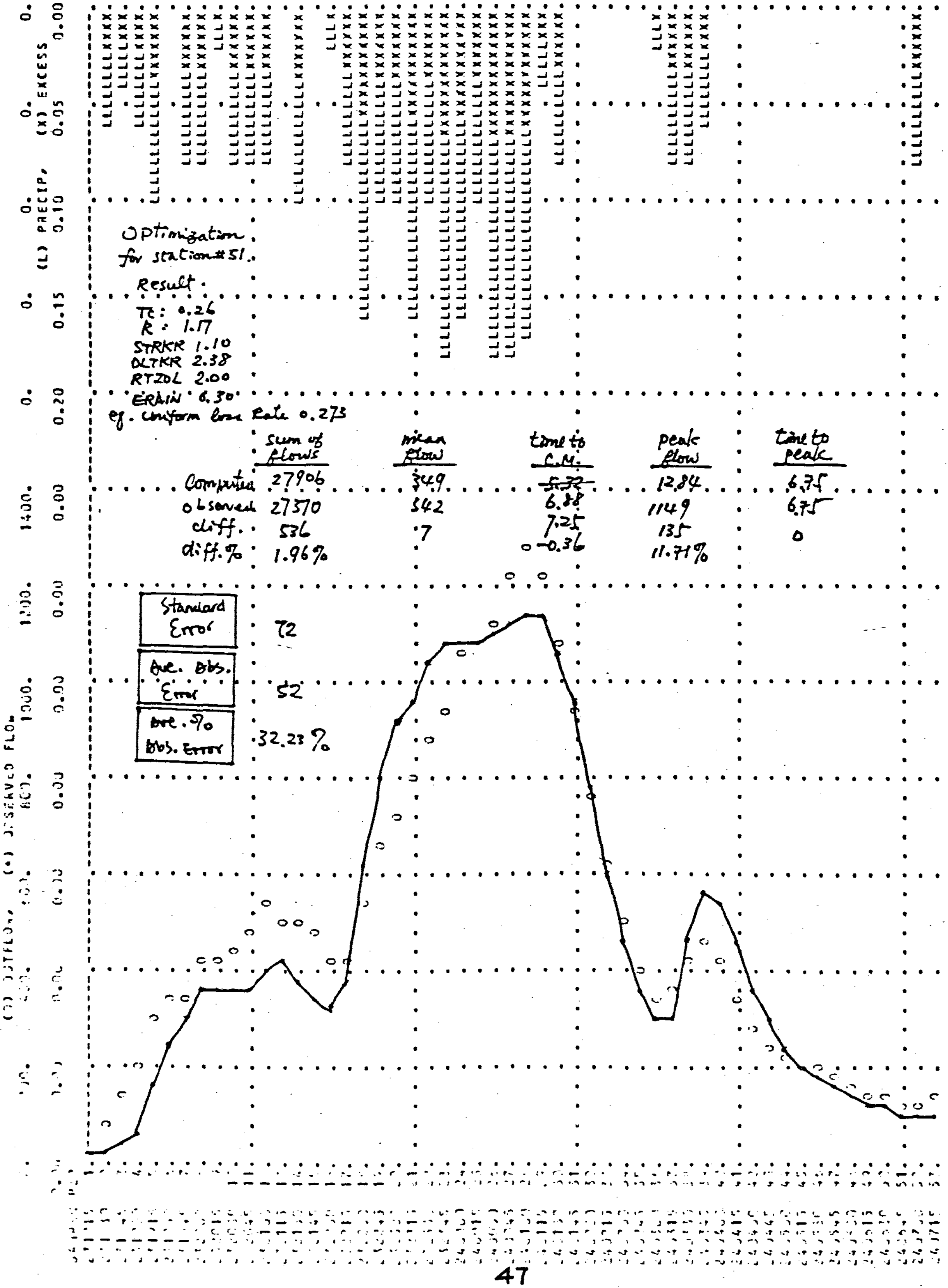
RESULT
TC 0.26
R 0.70

STRKR 0.23
DLTKR 0.64
RTIOL 1.06
ERAIN 0.54
EQUIVALENT UNIFORM LOSS RATE 0.135

Log from C.M to C.M
0.81

	sum of flow	mean of mass	time to C.M.	peak flow	time of peak
Computed	14177	177	6.25	861	6.75
observed	14177	177	7.13	1021	6.25
diff.	0	0	-0.88	-154	0.50
diff %	0%			-14.90%	
Standard error	110				
Ave. Abs. Error	67				
Ave. % Abs. Error	67.09%				

RUN2 p1



Optimization for station #51.

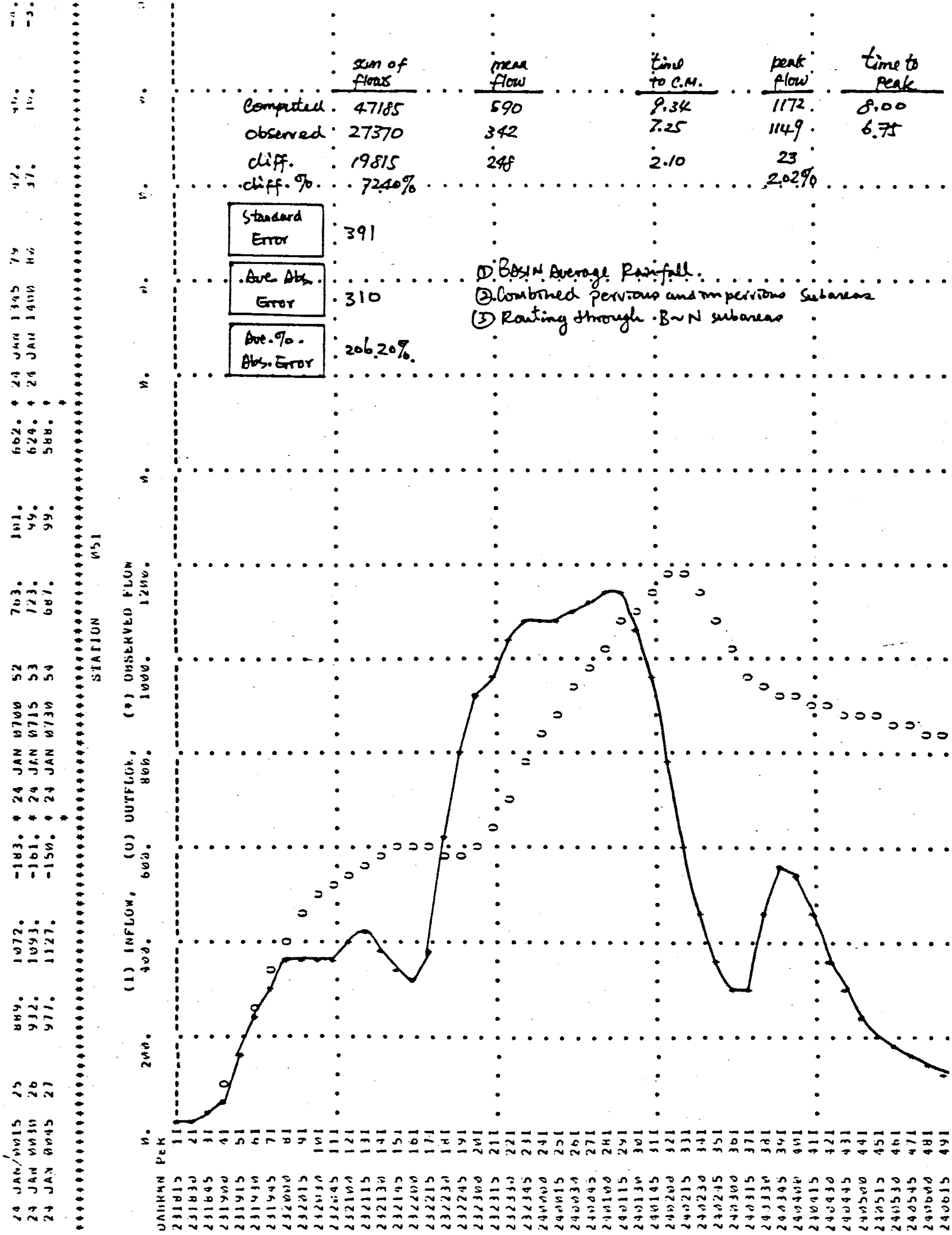
Result.

Tc: 0.26
R: 1.17
STRKR 1.10
DLTKR 2.38
RTIOL 2.00
ERAIN 6.30
eq. uniform loss Rate 0.273

	sum of flows	mean flow	time to C.M.	peak flow	time to peak
Computed	27906	349	~~5.72~~ 6.88	1284	6.75
observed	27370	342	7.25	1149	6.75
diff.	536	7	-0.36	135	0
diff. %	1.96%			11.71%	

Standard Error	72
Ave. Abs. Error	52
Ave. % Abs. Error	32.23%

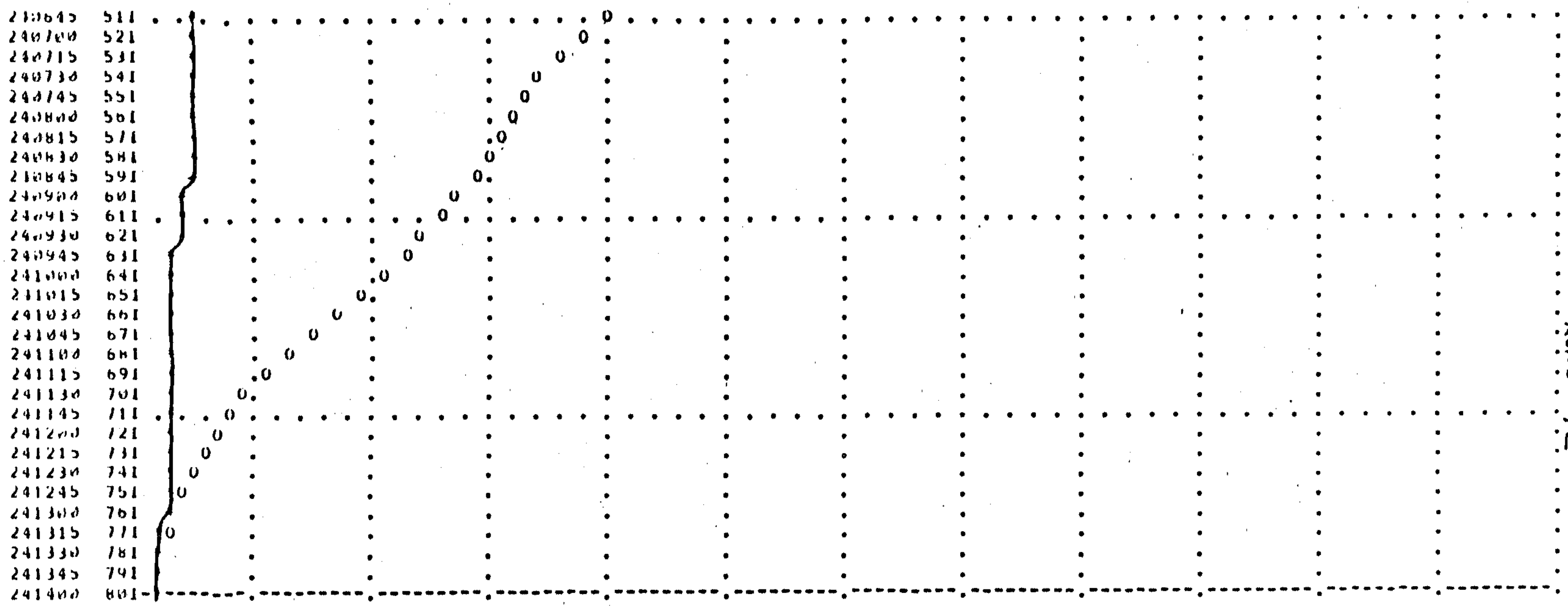
RUN3 P1



	sum of flows	mean flow	time to C.M.	peak flow	time to peak
Computed	47185	590	9.34	1172	8.00
observed	27370	342	7.25	1149	6.75
diff.	19815	248	2.10	23	
diff. %	72.40%			2.02%	

Standard Error	391
Ave. Abs. Error	310
Ave. % Abs. Error	206.20%

① Basin Average Rainfall.
② Combined pervious and impervious Subareas
③ Routing through B~N subareas



RUN3 P2

49

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                                   RUNOFF SUMMARY
                            FLOW IN CUBIC FEET PER SECOND
                         TIME IN HOURS,  AREA IN SQUARE MILES

                              PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN     MAXIMUM     TIME OF
  OPERATION       STATION     FLOW     PEAK                                               AREA      STAGE     MAX STAGE
                                                 6-HOUR       24-HOUR      72-HOUR

  HYDROGRAPH AT
                    00A        483.    7.00        241.         113.         113.         2.98

  ROUTED TO
                   1102        454.    7.25        240.         112.         112.         2.98

  HYDROGRAPH AT
                    00B        311.    6.75        156.          66.          66.         1.08

  ROUTED TO
                   AREA        115.   11.75        114.          66.          66.         1.08

  2 COMBINED AT
                    0AB        567.    7.25        350.         178.         178.         4.06

  ROUTED TO
                   2I03        547.    7.50        349.         178.         178.         4.06

  HYDROGRAPH AT
```

RUN4 P1

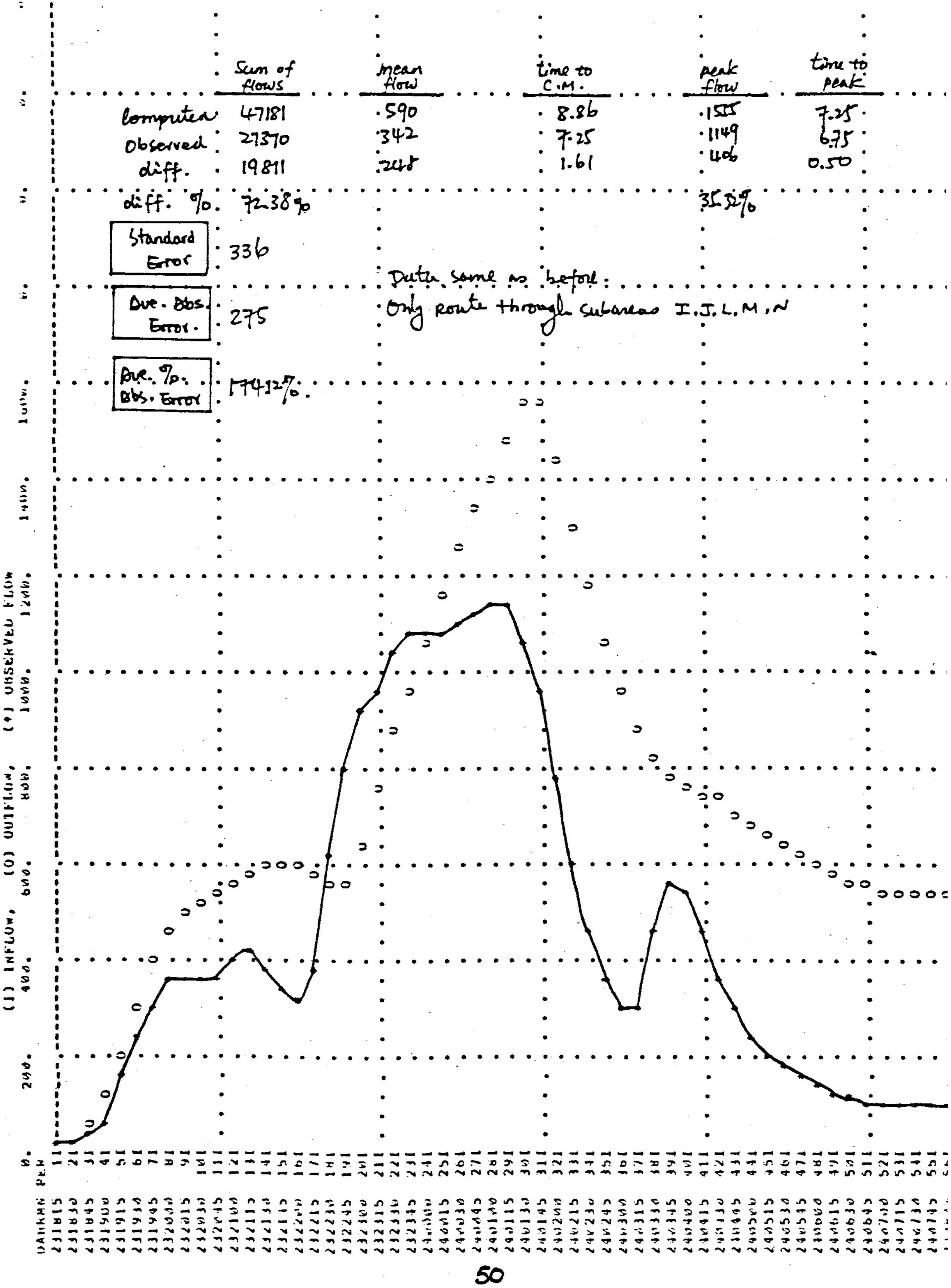
	Sum of flows	mean flow	time to C.M.	peak flow	time to peak
Computed	47181	590	8.86	1555	7.25
Observed	27370	342	7.25	1149	6.75
diff.	19811	248	1.61	406	0.50
diff. %	72.38%			35.32%	

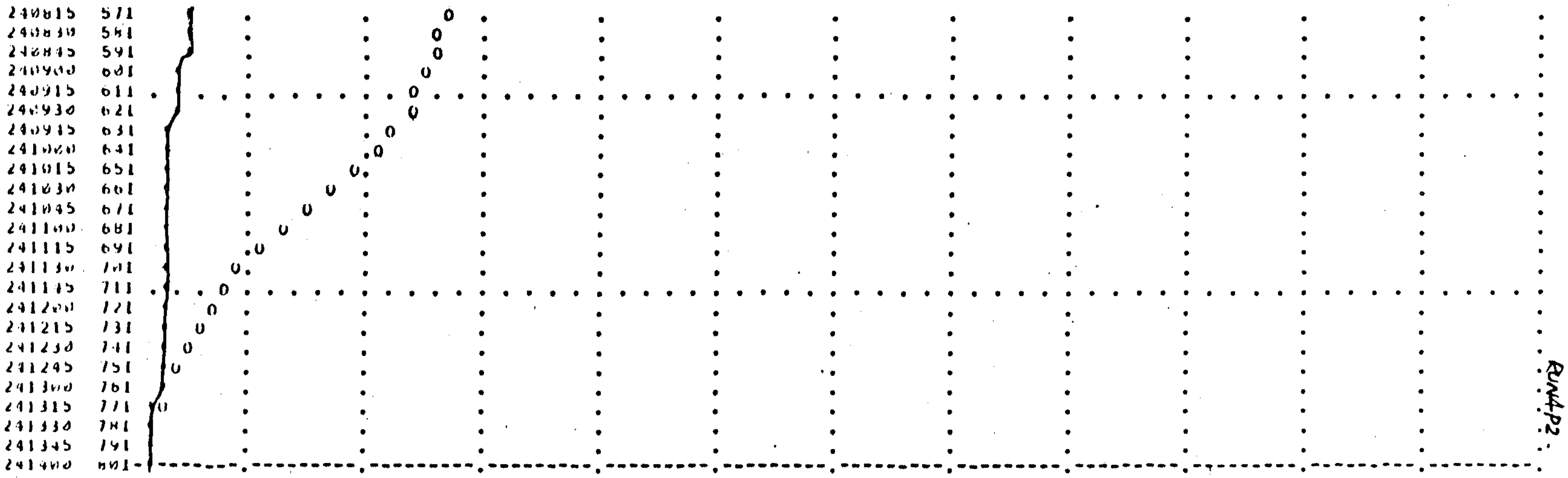
Standard Error 336

Ave. Abs. Error. 275

Ave. %. Abs. Error 174.12%.

Data same as before:
Only route through subareas I.J.L.M.N





Run4P2

57

```
                                         RUNOFF SUMMARY
                                  FLOW IN CUBIC FEET PER SECOND
                               TIME IN HOURS,  AREA IN SQUARE MILES

                                      PEAK    TIME OF        AVERAGE FLOW FOR MAXIMUM PERIOD          BASIN      MAXIMUM       TIME OF
           OPERATION      STATION     FLOW     PEAK                                                    AREA       STAGE      MAX STAGE
                                                            6-HOUR        24-HOUR       72-HOUR

           HYDROGRAPH AT
  +                         00A       483.     7.00          241.          113.          113.          2.98

           ROUTED TO
  +                        1T02       454.     7.25          240.          112.          112.          2.98

           HYDROGRAPH AT
  +                         00B       311.     6.75          156.           66.           66.          1.08

           2 COMBINED AT
  +                         0AB       706.     7.00          391.          178.          178.          4.06

           ROUTED TO
  +                        2T03       686.     7.00          390.          178.          178.          4.06

           HYDROGRAPH AT
  +                         00H       540.     6.75          265.          109.          109.          2.06

           2 COMBINED AT
  +                         ABH      1184.     6.75          652.          287.          287.          6.12

           ROUTED TO
  +                        3T04      1187.     7.00          651.          287.          287.          6.12

           HYDROGRAPH AT
```

```
 *     PERCENT DIFFERENCE            72.33                                                  2.53          97.02             *
 *                                                                                                                          *
 *                        STANDARD ERROR        377.                   AVERAGE ABSOLUTE ERROR        250.                   *
 *                    OBJECTIVE FUNCTION        501.           AVERAGE PERCENT ABSOLUTE ERROR        83.13                  *
 *                                                                                                                          *
 ****************************************************************************************************************************

**********************************************************************************************************************************

                                                 HYDROGRAPH AT STATION      051

**********************************************************************************************************************************
                                                  *                                                  *
 DA MON HRMN ORD     COMP Q     OBS Q   RESIDUL * DA MON HRMN ORD     COMP Q     OBS Q   RESIDUL * DA MON HRMN ORD     COMP Q     OBS Q   RESIDUL
                                                  *                                                  *
 23 JAN 1815    1       16.       22.       -6. * 24 JAN 0100   28     2228.     1149.     1079. * 24 JAN 0745   55      373.      157.      216.
 23 JAN 1830    2       47.       22.       25. * 24 JAN 0115   29     2264.     1134.     1130. * 24 JAN 0800   56      342.      147.      195.
 23 JAN 1845    3      123.       32.       91. * 24 JAN 0130   30     2118.     1067.     1051. * 24 JAN 0815   57      269.      102.      167.
 23 JAN 1900    4      218.       57.      161. * 24 JAN 0145   31     1884.      964.      920. * 24 JAN 0830   58      236.       99.      137.
 23 JAN 1915    5      345.      150.      195. * 24 JAN 0200   32     1608.      772.      836. * 24 JAN 0845   59      209.       90.      119.
 23 JAN 1930    6      453.      234.      219. * 24 JAN 0215   33     1357.      608.      749. * 24 JAN 0900   60      185.       81.      104.
 23 JAN 1945    7      495.      299.      196. * 24 JAN 0230   34     1153.      469.      684. * 24 JAN 0915   61      144.       81.       63.
 23 JAN 2000    8      538.      355.      183. * 24 JAN 0245   35      976.      365.      611. * 24 JAN 0930   62      140.       77.       63.
 23 JAN 2015    9      568.      359.      209. * 24 JAN 0300   36      817.      301.      516. * 24 JAN 0945   63      131.       67.       64.
 23 JAN 2030   10      568.      352.      216. * 24 JAN 0315   37      695.      301.      394. * 24 JAN 1000   64      117.       67.       50.
 23 JAN 2045   11      594.      369.      225. * 24 JAN 0330   38      689.      460.      229. * 24 JAN 1015   65      106.       67.       39.
 23 JAN 2100   12      657.      405.      252. * 24 JAN 0345   39      729.      567.      162. * 24 JAN 1030   66       95.       63.       32.
 23 JAN 2115   13      666.      414.      252. * 24 JAN 0400   40      730.      538.      192. * 24 JAN 1045   67       86.       61.       25.
 23 JAN 2130   14      638.      384.      254. * 24 JAN 0415   41      681.      458.      223. * 24 JAN 1100   68       79.       59.       20.
 23 JAN 2145   15      611.      331.      280. * 24 JAN 0430   42      611.      365.      246. * 24 JAN 1115   69       72.       59.       13.
 23 JAN 2200   16      556.      312.      244. * 24 JAN 0445   43      539.      299.      240. * 24 JAN 1130   70       66.       59.        7.
 23 JAN 2215   17      501.      388.      116. * 24 JAN 0500   44      471.      245.      229. * 24 JAN 1145   71       60.       57.        3.
 23 JAN 2230   18      589.      629.      -40. * 24 JAN 0515   45      418.      202.      216. * 24 JAN 1200   72       56.       55.        1.
 23 JAN 2245   19      806.      797.        9. * 24 JAN 0530   46      369.      175.      194. * 24 JAN 1215   73       51.       55.       -4.
 23 JAN 2300   20     1014.      912.      102. * 24 JAN 0545   47      327.      151.      176. * 24 JAN 1230   74       48.       51.       -3.
 23 JAN 2315   21     1199.      969.      230. * 24 JAN 0600   48      291.      136.      155. * 24 JAN 1245   75       44.       51.       -7.
 23 JAN 2330   22     1364.     1034.      330. * 24 JAN 0615   49      262.      118.      144. * 24 JAN 1300   76       41.       51.      -10.
 23 JAN 2345   23     1515.     1070.      445. * 24 JAN 0630   50      232.      116.      116. * 24 JAN 1315   77       38.       49.      -11.
 24 JAN 0000   24     1705.     1074.      631. * 24 JAN 0645   51      209.      108.      101. * 24 JAN 1330   78       36.       47.      -11.
 24 JAN 0015   25     1855.     1072.      783. * 24 JAN 0700   52      227.      101.      126. * 24 JAN 1345   79       34.       46.      -12.
 24 JAN 0030   26     1947.     1093.      854. * 24 JAN 0715   53      283.       99.      184. * 24 JAN 1400   80       31.       40.       -9.
 24 JAN 0045   27     2070.     1127.      943. * 24 JAN 0730   54      319.       99.      220. *
                                                  *                                                  *
**********************************************************************************************************************************
1                                                              STATION      051
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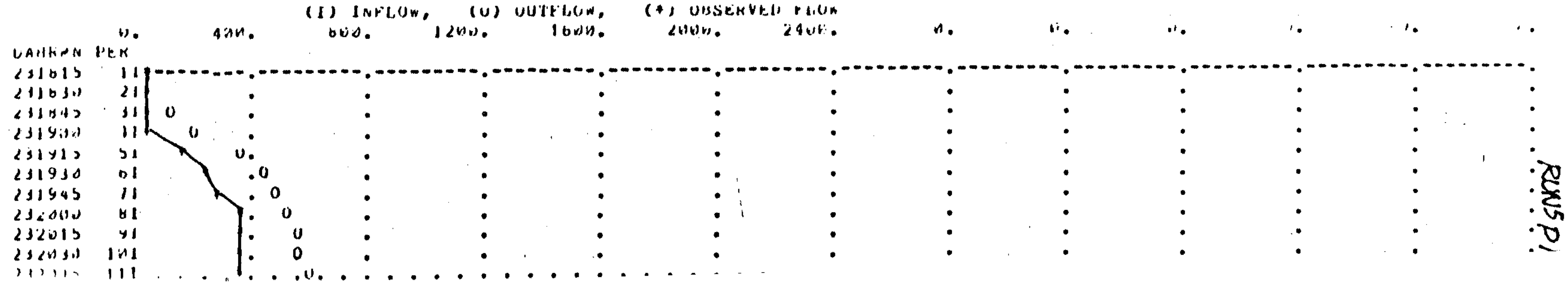
52

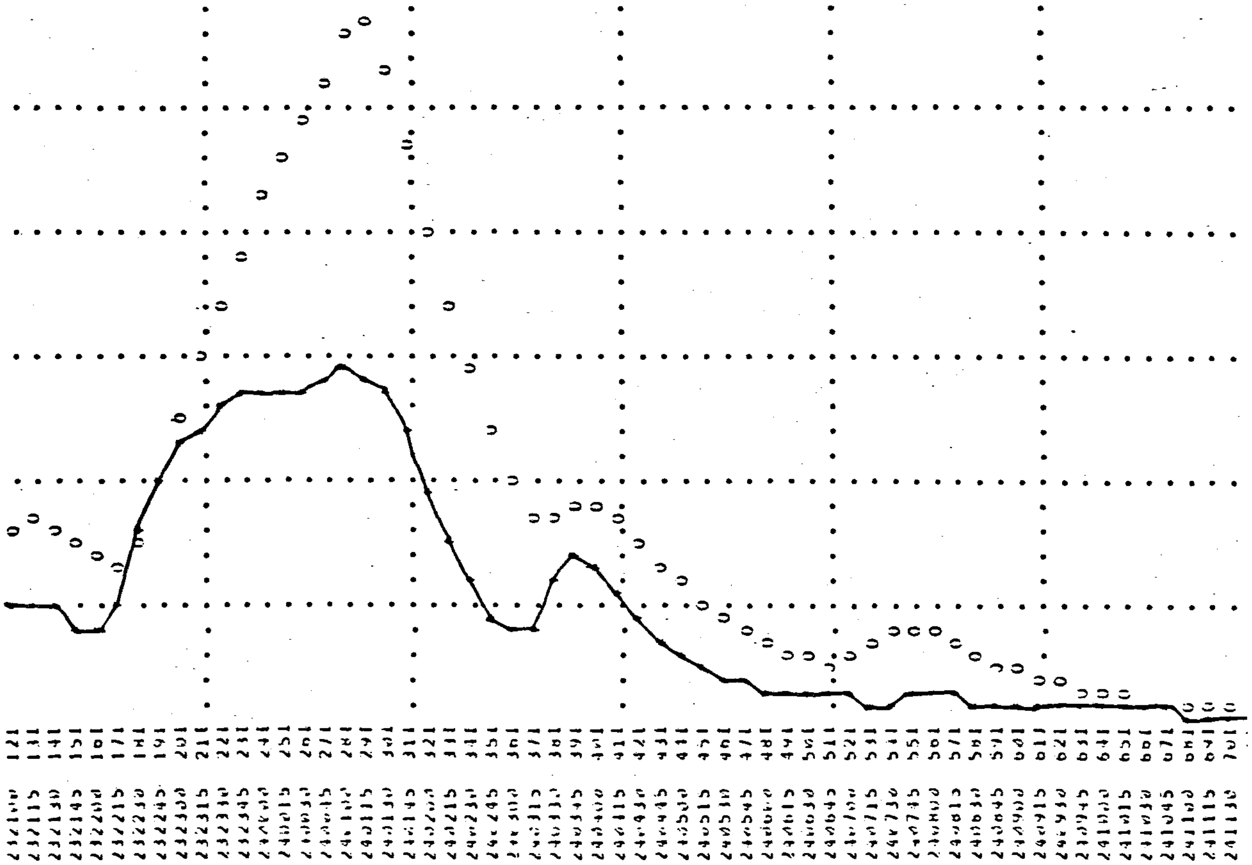


RUN5 P1

RUN5 P2

	Sum of flows	mean flow.	Time to C.M.	peak flow	time of peak
Computed	47168	590	7.43	2264	7.00
observed	27370	342	7.25	1149	6.75
Diff.	19798	247	0.18	1115	0.25
diff. %	72.33%			2.53%	

Standard Error	377
Ave. Abs. Error	250
Ave. % Abs. Error	83.13%



RUNG P1

	Sum of flows	mean flow	Time to C.M.	Peak flow	Time to peak
Computed	48209	603	9.21	1316	8.00
Observed	27370	342	7.25	1149	6.75
diff.	20839	260	1.97	167	1.25
Diff. %	76.14			14.5%	

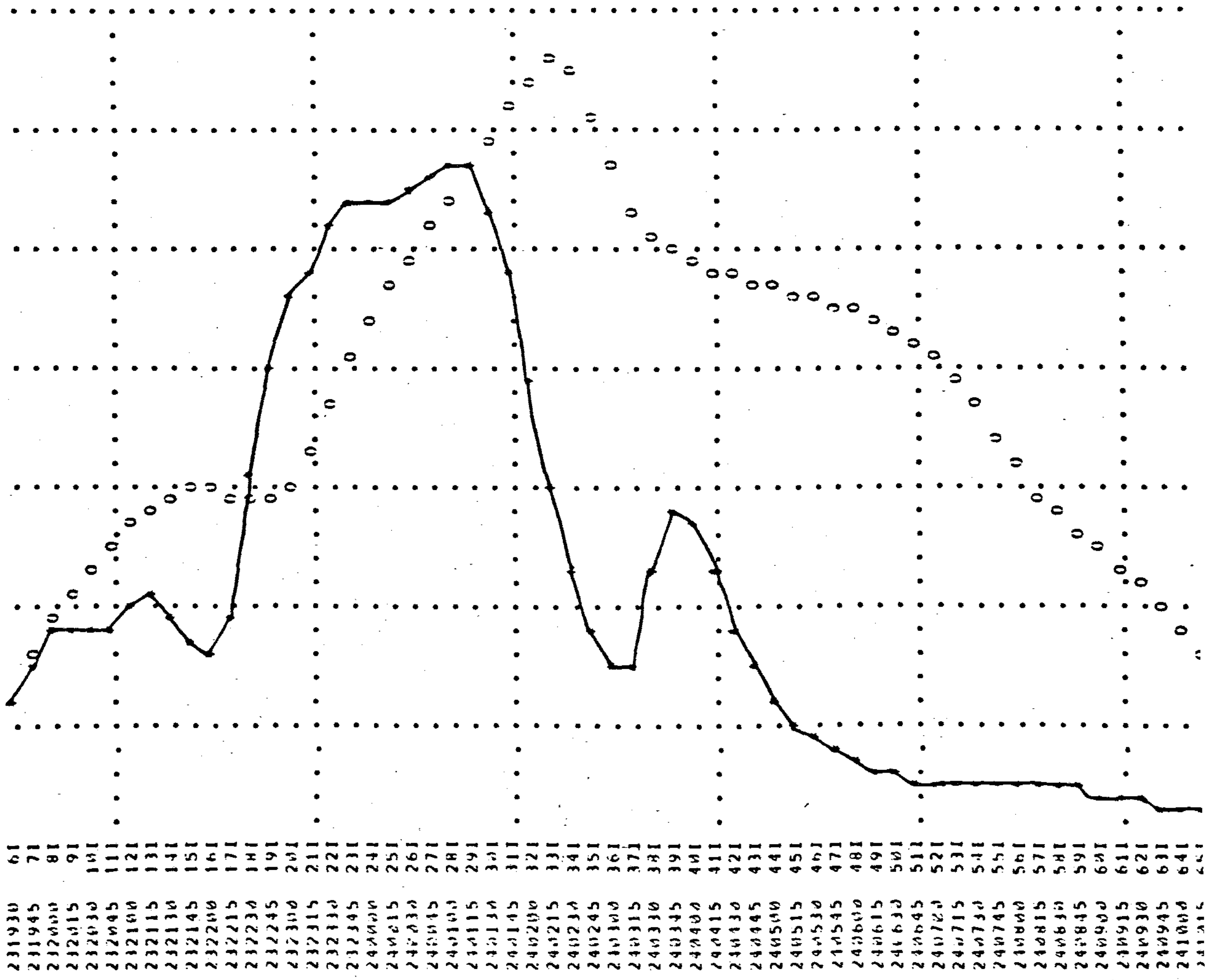
Standard Error	415
Ave. Abs. Error	312
Ave. % Abs. Error	192.25

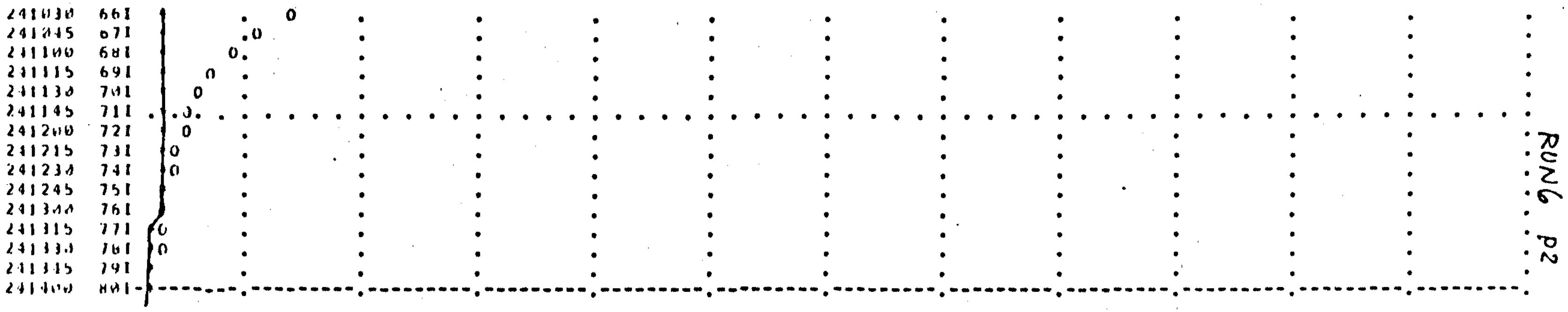
Data changed on Rainfall Distribution

Use Theissen method.

All other remained same

(whole area routing. (except A, as usual))





RUN6 P2

```
1
1
                                          RUNOFF SUMMARY
                                    FLOW IN CUBIC FEET PER SECOND
                                 TIME IN HOURS,  AREA IN SQUARE MILES

                                     PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN    MAXIMUM     TIME OF
        OPERATION        STATION     FLOW     PEAK                                               AREA     STAGE    MAX STAGE
                                                       6-HOUR       24-HOUR      72-HOUR

        HYDROGRAPH AT
+                          00A       699.     7.00      327.         152.         152.          2.98

        ROUTED TO
+                         1T02       618.     7.25      325.         152.         152.          2.98

        HYDROGRAPH AT
+                          00B       286.     6.75      143.          63.          63.          1.28

        ROUTED TO
+                         AREA       114.    11.25      113.          63.          63.          1.28

        2 COMBINED AT
+                          0AB       736.     7.25      435.         215.         215.          4.06

        ROUTED TO
+                         2T03       705.     7.50      434.         214.         214.          4.06

        HYDROGRAPH AT
+                          00H       748.     7.00      356.         149.         149.          2.06

        ROUTED TO
+                         AREA       228.     8.25      225.         149.         149.          2.06

        2 COMBINED AT
+                          ABH       931.     7.50      657.         364.         364.          6.12

        ROUTED TO
+                         3T04       921.     7.75      656.         363.         363.          6.12

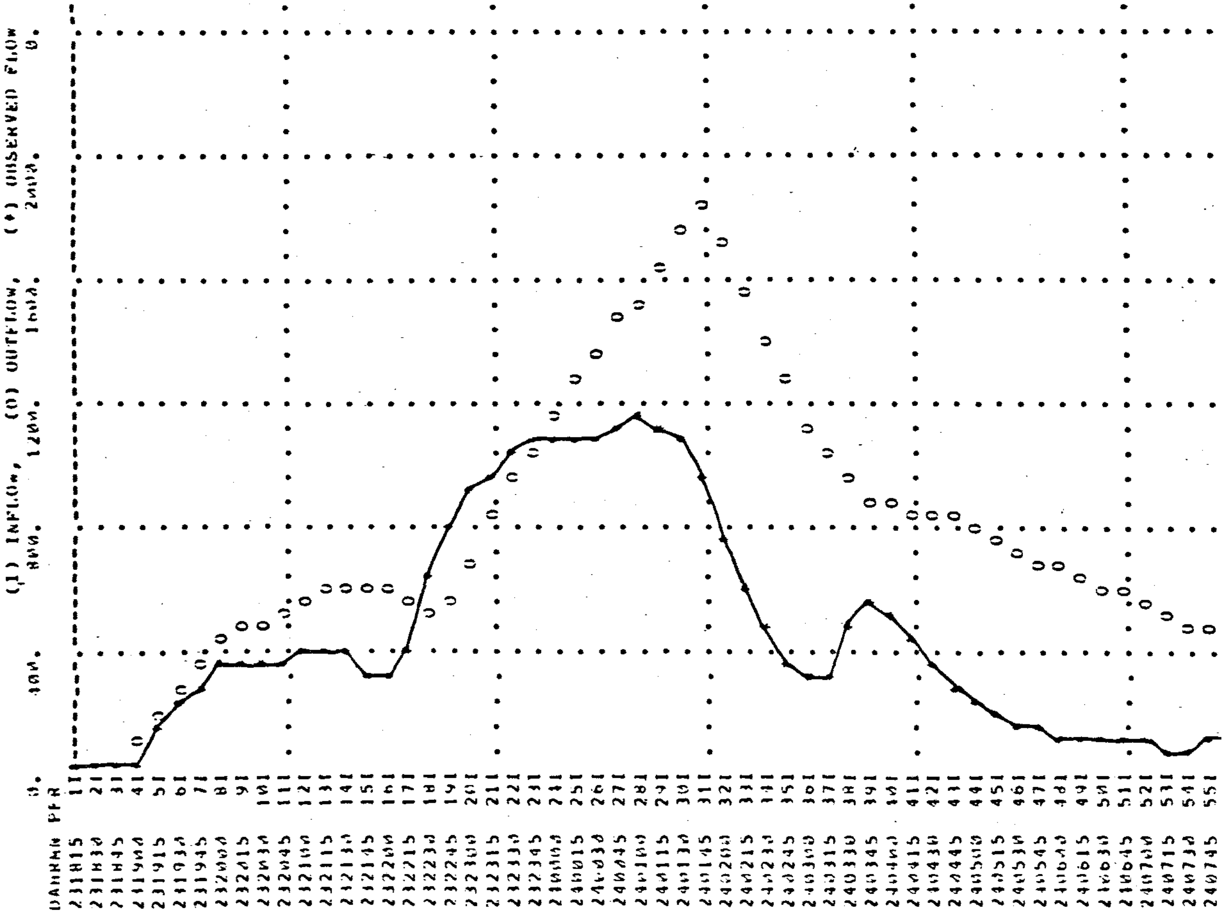
        HYDROGRAPH AT
+                          00J       146.     6.75       77.          33.          33.          0.41

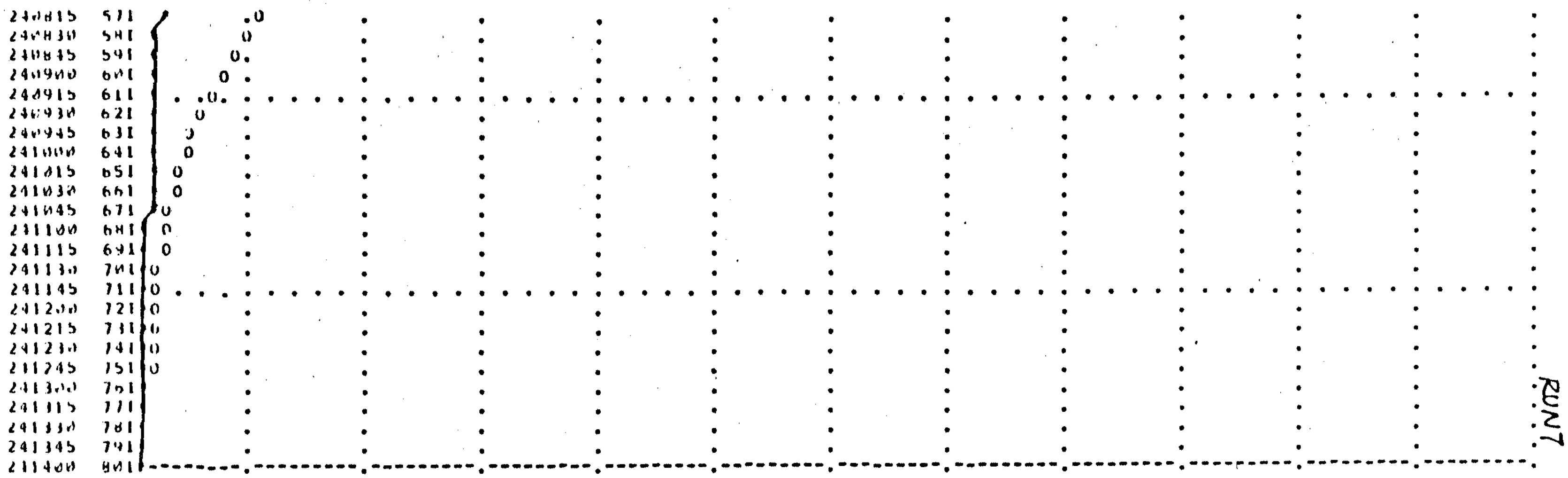
        ROUTED TO
```

RUN 7

	Sum of flows	mean flow	Time to C.M.	Peak flow	Peak times
Computed	48210	603	8.46	1829	7.50
Observed	27370	342	7.25	1149	6.75
Diff.	20840	260	1.22	680	0.75
Diff. %	76.14			59.16%	
Standard Error	383				
Ave. Abs. error	281				
Ave. %. Abs error.	134.97				

Route through I, J, L, M, N only.
Theissen Rainfall Distribution.





RUNT P2

57

```
                                 RUNOFF SUMMARY
                          FLOW IN CUBIC FEET PER SECOND
                       TIME IN HOURS,  AREA IN SQUARE MILES

                            PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN    MAXIMUM    TIME OF
  OPERATION      STATION    FLOW     PEAK                                               AREA     STAGE    MAX STAGE
                                                 6-HOUR      24-HOUR      72-HOUR

+ HYDROGRAPH AT
                   0AA      699.     7.00        327.         152.         152.          2.98

+ ROUTED TO
                  1T02      618.     7.25        325.         152.         152.          2.98

+ HYDROGRAPH AT
                   00B      286.     6.75        143.          63.          63.          1.06

+ 2 COMBINED AT
                   0AB      791.     7.00        461.         215.         215.          4.06

+ ROUTED TO
                  2T03      777.     7.25        460.         214.         214.          4.06

+ HYDROGRAPH AT
                   00H      738.     7.00        356.         149.         149.          2.06

+ 2 COMBINED AT
                   ABH     1507.     7.00        814.         364.         364.          6.12

+ ROUTED TO
                  3T04     1477.     7.00        810.         363.         363.          6.12
```

```
 *      PERCENT DIFFERENCE           76.06                                                      5.38          65.29        *
 *                                                                                                                         *
 *                             STANDARD ERROR        394.                  AVERAGE ABSOLUTE ERROR        263.              *
 *                          OBJECTIVE FUNCTION       508.          AVERAGE PERCENT ABSOLUTE ERROR        86.54             *
 *                                                                                                                         *
 ***************************************************************************************************************************

*******************************************************************************************************************************

                                                      HYDROGRAPH AT STATION       051

*******************************************************************************************************************************
                                                 *                                                       *
 DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL    * DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL    * DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL
                                                 *                                                       *
 23 JAN 1815   1       16.       22.       -6.   * 24 JAN 0100  28     2129.     1149.      980.   * 24 JAN 0745  55      280.      107.      173.
 23 JAN 1830   2       21.       22.       -1.   * 24 JAN 0115  29     2128.     1134.      994.   * 24 JAN 0800  56      280.      107.      173.
 23 JAN 1845   3       94.       32.       62.   * 24 JAN 0130  30     2121.     1067.     1054.   * 24 JAN 0815  57      262.      102.      160.
 23 JAN 1900   4      211.       57.      154.   * 24 JAN 0145  31     2021.      964.     1057.   * 24 JAN 0830  58      237.       90.      147.
 23 JAN 1915   5      327.      150.      177.   * 24 JAN 0200  32     1805.      772.     1033.   * 24 JAN 0845  59      215.       90.      125.
 23 JAN 1930   6      419.      234.      165.   * 24 JAN 0215  33     1544.      608.      936.   * 24 JAN 0900  60      195.       81.      114.
 23 JAN 1945   7      439.      299.      140.   * 24 JAN 0230  34     1330.      469.      861.   * 24 JAN 0915  61      177.       81.       96.
 23 JAN 2000   8      469.      355.      114.   * 24 JAN 0245  35     1142.      365.      777.   * 24 JAN 0930  62      162.       77.       85.
 23 JAN 2015   9      513.      359.      154.   * 24 JAN 0300  36      963.      301.      662.   * 24 JAN 0945  63      148.       87.       61.
 23 JAN 2030  10      551.      352.      202.   * 24 JAN 0315  37      852.      301.      551.   * 24 JAN 1000  64      135.       67.       68.
 23 JAN 2045  11      577.      369.      208.   * 24 JAN 0330  38      795.      460.      335.   * 24 JAN 1015  65      124.       67.       57.
 23 JAN 2100  12      603.      405.      196.   * 24 JAN 0345  39      779.      567.      212.   * 24 JAN 1030  66      115.       65.       50.
 23 JAN 2115  13      624.      414.      210.   * 24 JAN 0400  40      751.      538.      213.   * 24 JAN 1045  67      106.       61.       45.
 23 JAN 2130  14      632.      384.      248.   * 24 JAN 0415  41      715.      458.      257.   * 24 JAN 1100  68       98.       59.       39.
 23 JAN 2145  15      628.      331.      297.   * 24 JAN 0430  42      667.      365.      302.   * 24 JAN 1115  69       91.       59.       32.
 23 JAN 2200  16      558.      312.      246.   * 24 JAN 0445  43      603.      259.      344.   * 24 JAN 1130  70       84.       59.       25.
 23 JAN 2215  17      511.      388.      123.   * 24 JAN 0500  44      537.      245.      292.   * 24 JAN 1145  71       78.       57.       21.
 23 JAN 2230  18      572.      629.      -57.   * 24 JAN 0515  45      479.      202.      277.   * 24 JAN 1200  72       73.       55.       18.
 23 JAN 2245  19      733.      797.      -64.   * 24 JAN 0530  46      430.      175.      255.   * 24 JAN 1215  73       66.       55.       11.
 23 JAN 2300  20      944.      912.       32.   * 24 JAN 0545  47      386.      151.      235.   * 24 JAN 1230  74       64.       51.       13.
 23 JAN 2315  21     1144.      969.      175.   * 24 JAN 0600  48      348.      136.      212.   * 24 JAN 1245  75       60.       51.        9.
 23 JAN 2330  22     1297.     1034.      263.   * 24 JAN 0615  49      315.      116.      199.   * 24 JAN 1300  76       56.       51.        5.
 23 JAN 2345  23     1483.     1070.      414.   * 24 JAN 0630  50      286.      116.      170.   * 24 JAN 1315  77       53.       49.        4.
 24 JAN 0000  24     1685.     1074.      611.   * 24 JAN 0645  51      260.      108.      152.   * 24 JAN 1330  78       50.       49.        1.
 24 JAN 0015  25     1807.     1072.      735.   * 24 JAN 0700  52      246.      111.      135.   * 24 JAN 1345  79       47.       46.        1.
 24 JAN 0030  26     1867.     1093.      774.   * 24 JAN 0715  53      253.       99.      154.   * 24 JAN 1400  80       44.       44.        0.
 24 JAN 0045  27     2009.     1127.      882.   * 24 JAN 0730  54      268.       99.      169.   *
                                                 *                                                       *
*******************************************************************************************************************************
1                                                               STATION      051

                                 (I) INFLOW,    (O) OUTFLOW,    (*) OBSERVED FLOW
               0.        400.       800.      1200.      1600.      2000.      2400.          0.         0.         0.         0.         0.         0.
DAHRMN PER
231815    1I*---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
231830    2I          .         .         .         .         .         .         .         .         .         .         .         .
231845    3I O        .         .         .         .         .         .         .         .         .         .         .         .
231900    4I     O    .         .         .         .         .         .         .         .         .         .         .         .
231915    5I   *    O .         .         .         .         .         .         .         .         .         .         .         .
231930    6I      *    O        .         .         .         .         .         .         .         .         .         .         .
231945    7I        *  .O       .         .         .         .         .         .         .         .         .         .         .
232000    8I          *. O      .         .         .         .         .         .         .         .         .         .         .
232015    9I          *.  O     .         .         .         .         .         .         .         .         .         .         .
232030   10I          *.   O    .         .         .         .         .         .         .         .         .         .         .
```

88

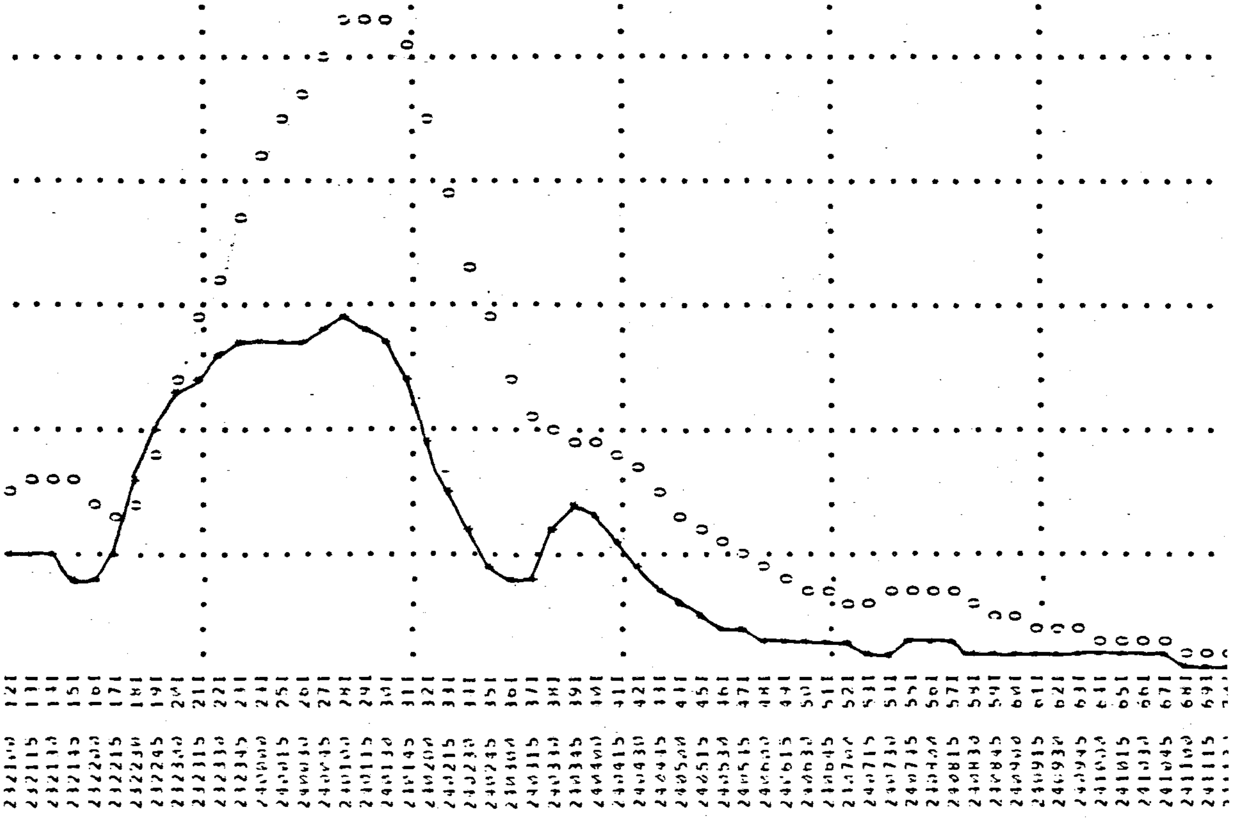
RUNS P1

RUN8

	Sum of flow	mean flow	time to C.M:	peak flow	time to peak
Computed	48188	602	7.64	2129	6.75
Observed	27370	342	7.25	1149	6.75
Diff.	20818	260	0.39	980	0.0
Diff. %	76.06			85.38%	

Standard Error	394
Ave. Abs. Error	263
Ave. % Abs. Error	88.88%

No Routing
Theissen Rainfall Distribution.



RUN 9 P1

STORM 1

SUBAREA RAIN (Theisson Rainfall Distribution)

1. SUBAREAS 3-N PULS ROUTED

(b). PERVIOUS/IMPERVIOUS (separated P/I parts of a subarea).

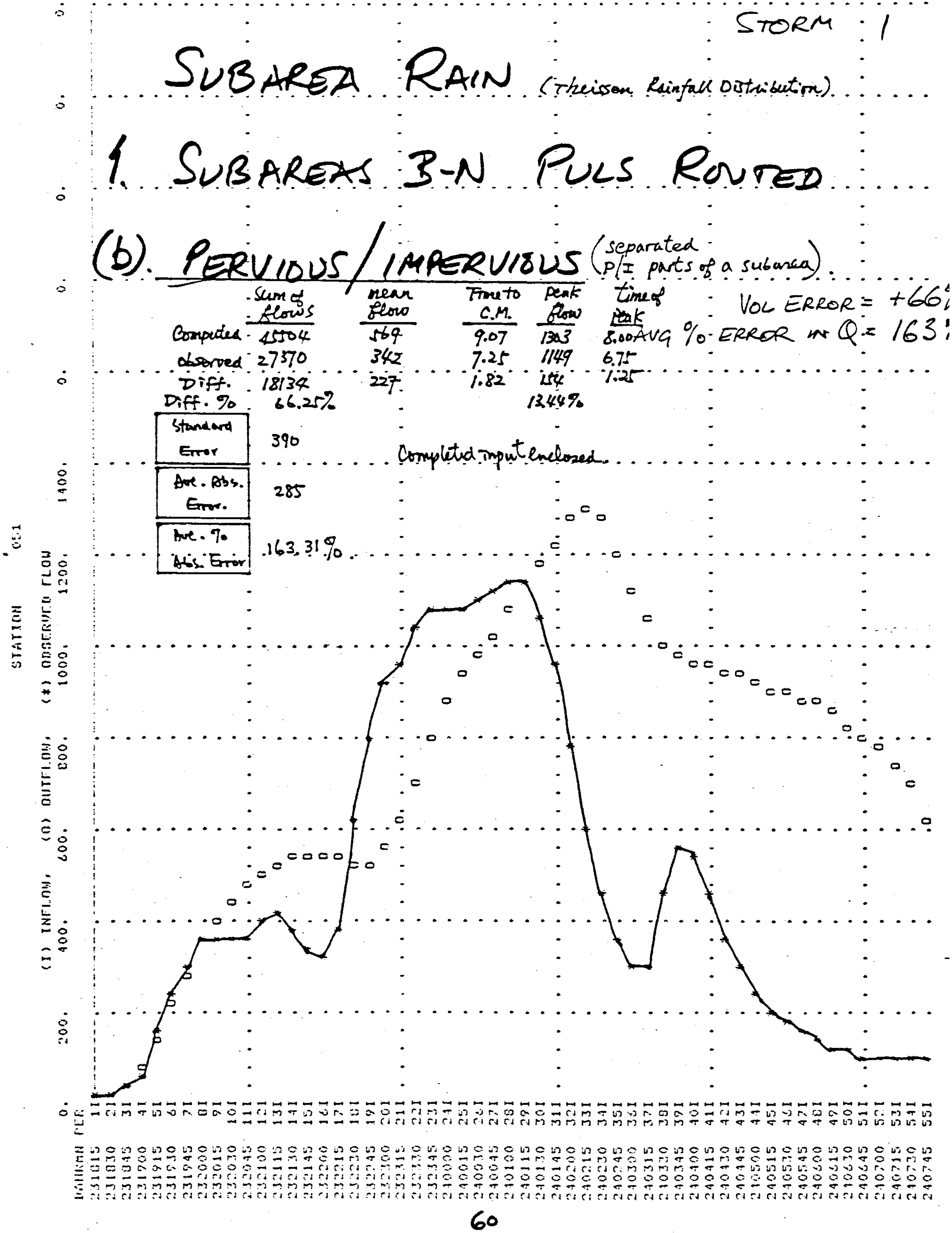
VOL ERROR = +66

AVG % ERROR IN Q = 163

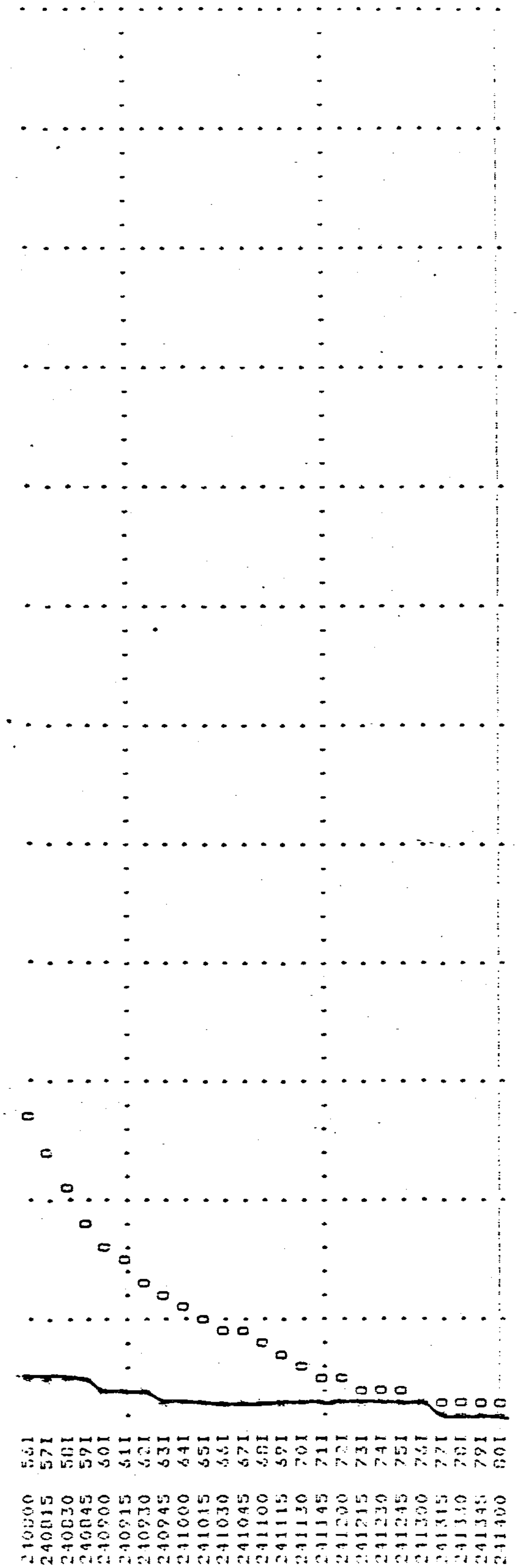
	Sum of flows	mean flow	Time to C.M.	Peak flow	time of peak
Computed	45504	569	9.07	1303	8.00
observed	27370	342	7.25	1149	6.75
Diff.	18134	227	1.82	154	1.25
Diff. %	66.25%			13.44%	

Standard Error	390
Ave. Abs. Error.	285
Ave. % Abs. Error	163.31%

Completed input enclosed.



RUN 9 P2


240800 561
240815 571
240830 581
240845 591
240900 601
240915 611
240930 621
240945 631
241000 641
241015 651
241030 661
241045 671
241100 681
241115 691
241130 701
241145 711
241200 721
241215 731
241230 741
241245 751
241300 761
241315 771
241330 781
241345 791
241400 801

RUN 10 p1

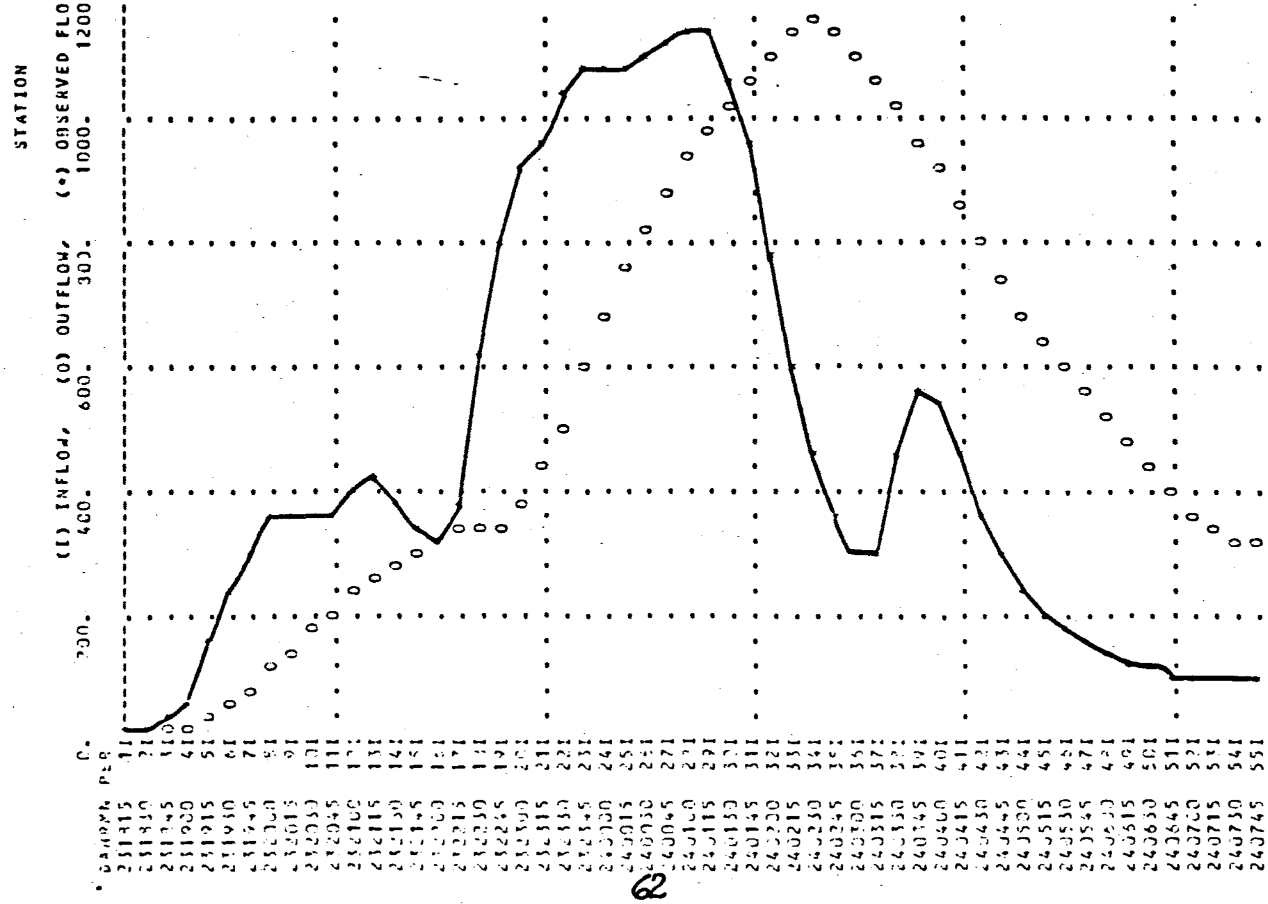
	Sum of flow	Time to center of mass	Peak flow	Time of peak	mean Flow
Computed :	32206	8.84			
observed	27370	7.25	1158	8.25	403
Difference	4836	1.59	1149	6.75	342
% Difference	17.67		9 0.76	1.50	60

Ave. % Abs. error	94.70%
Ave. Abs. error	228
Standard error	307

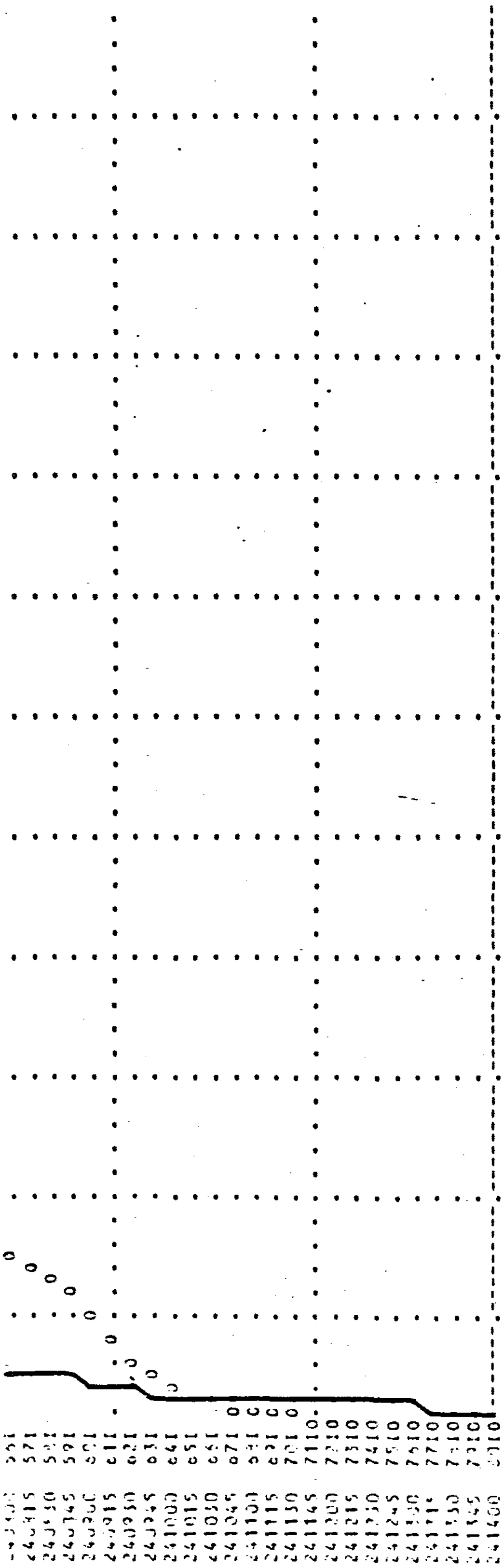
① THIESSEN METHOD DISTRIBUTED RAINFALL:
(the runs after this all use Theissen Rainfall until specifying Isoheytal method)

② B~N subareas devided into pervious & impervious parts

③ Drop the percentage parameters in LE card of both pervious and impervious parts. Use loss rate to specify their loss only.



RUN 10 P2



571
581
591
601
611
621
631
641
651
661
671
681
691
701
7110
7210
7310
7410
7510
7610
7710
7810
7910
8010
241000
241015
241030
241045
241100
241115
241130
241145
241200
241215
241230
241245
241300
241330
241345
241400

63

RUN II P1

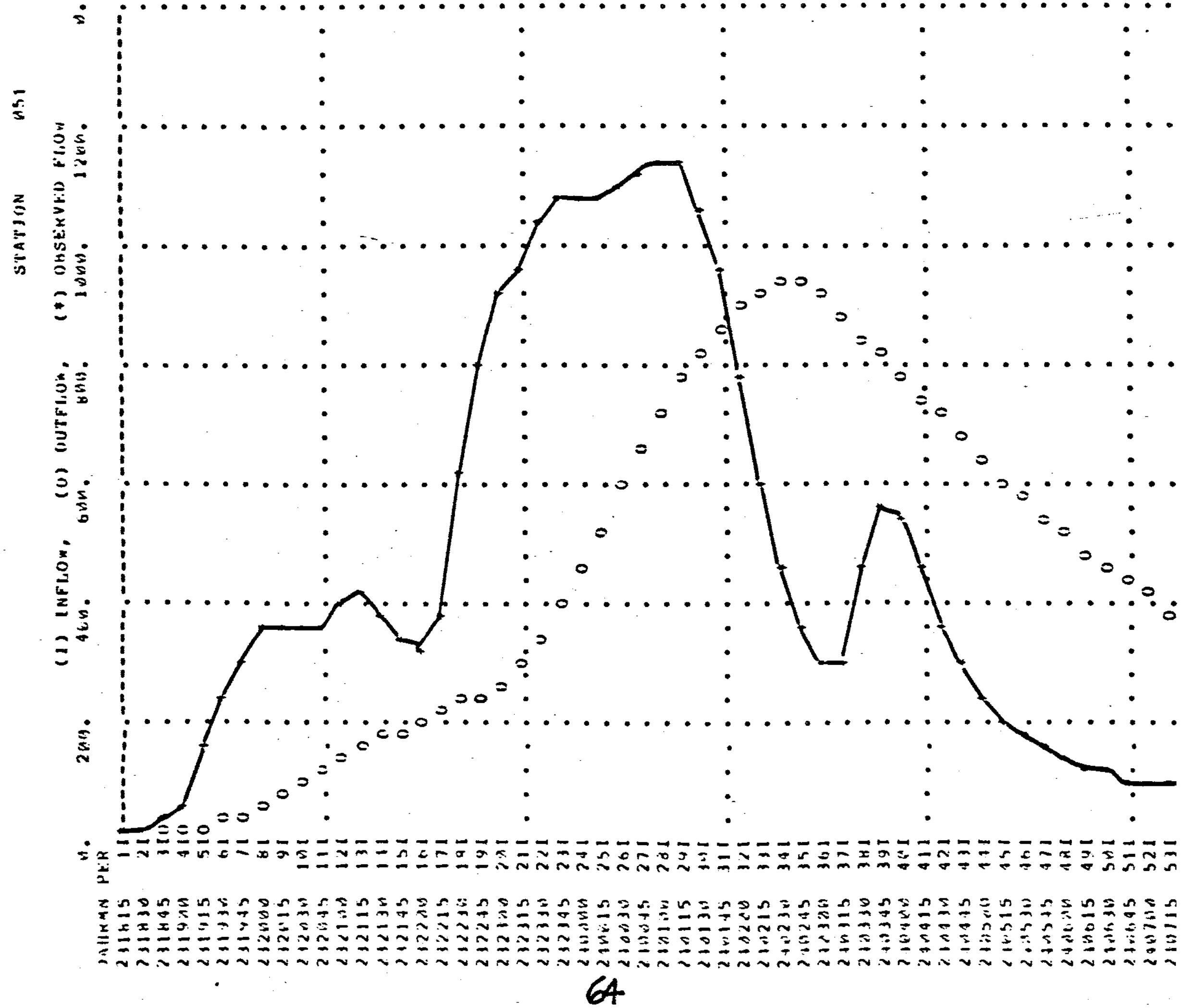
all data same as 10 except

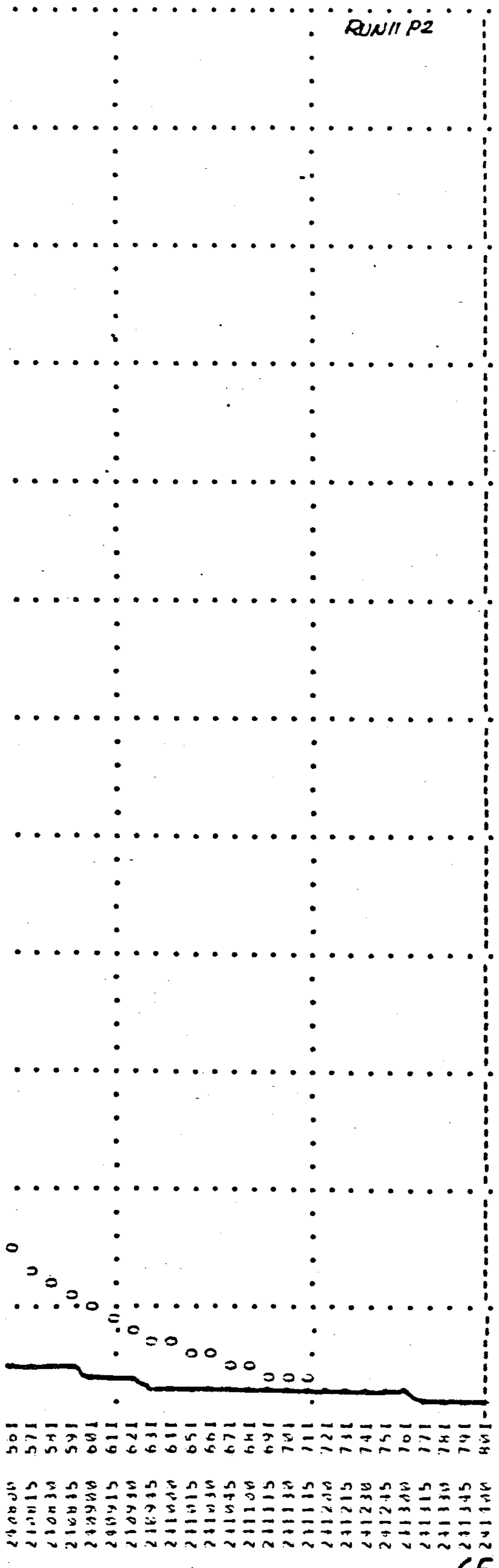
all Routing Coefficient R have been multiply by 3

means adjustment 300%

	Sum of Flow	mean Flow	Time to C.M.	Peak Flow	Time to Peak Flow
Computed.	27567	345	9.54	932	8.25
Observed	27370	342	7.25	1149	6.75
Diff.	197	2	2.30	-217	1.50
Diff. %	0.72			-18.87	

Standard Error	316
Ave. Abs. Error	247
Ave. % Abs. Er.	96.14 %




RUN11 P2
561
571
581
591
601
611
621
631
641
651
661
671
681
691
701
711
721
731
741
751
761
771
781
791
801

RUN 12 P1

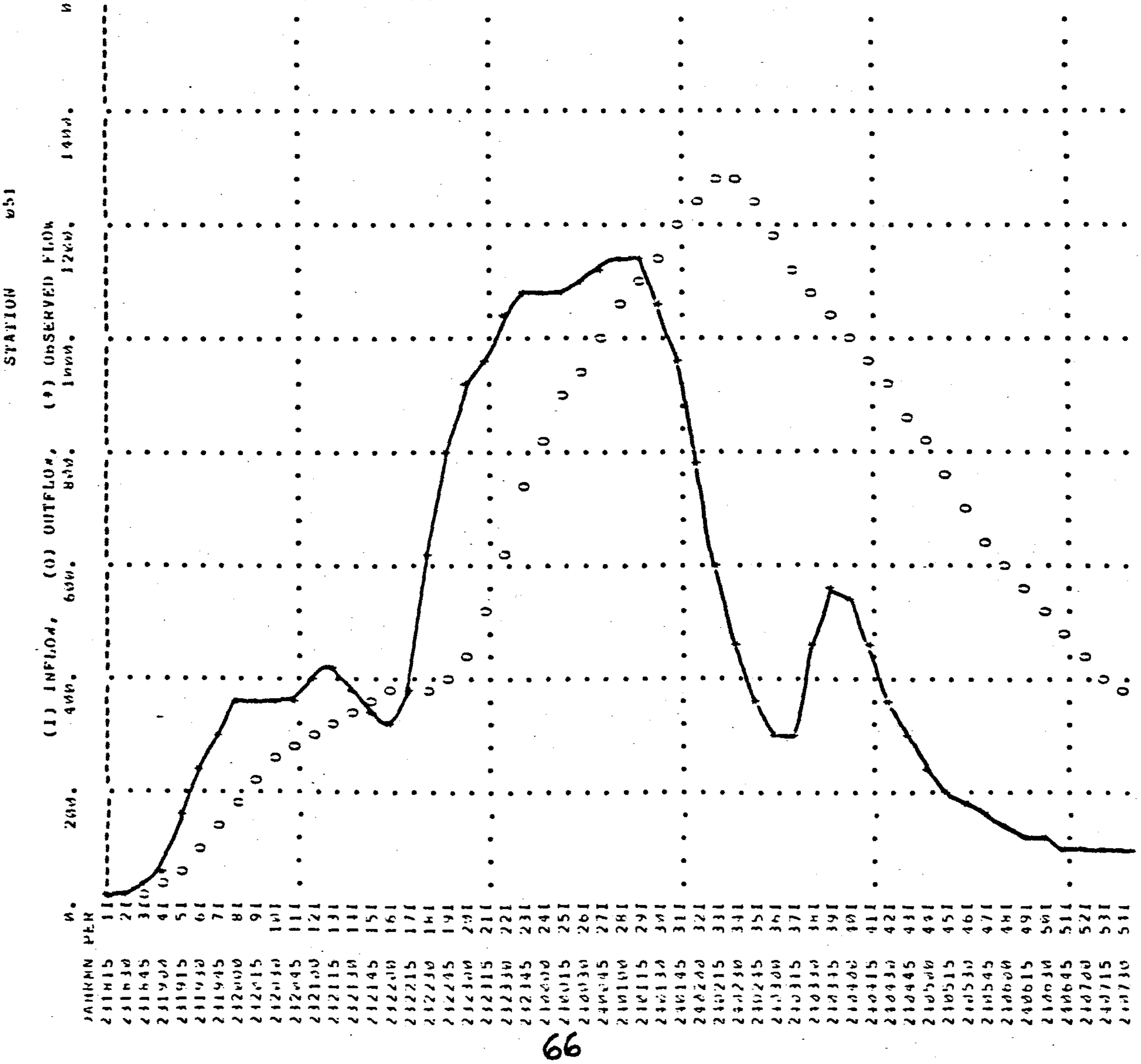
all R's are devided by 3 from the data of 10

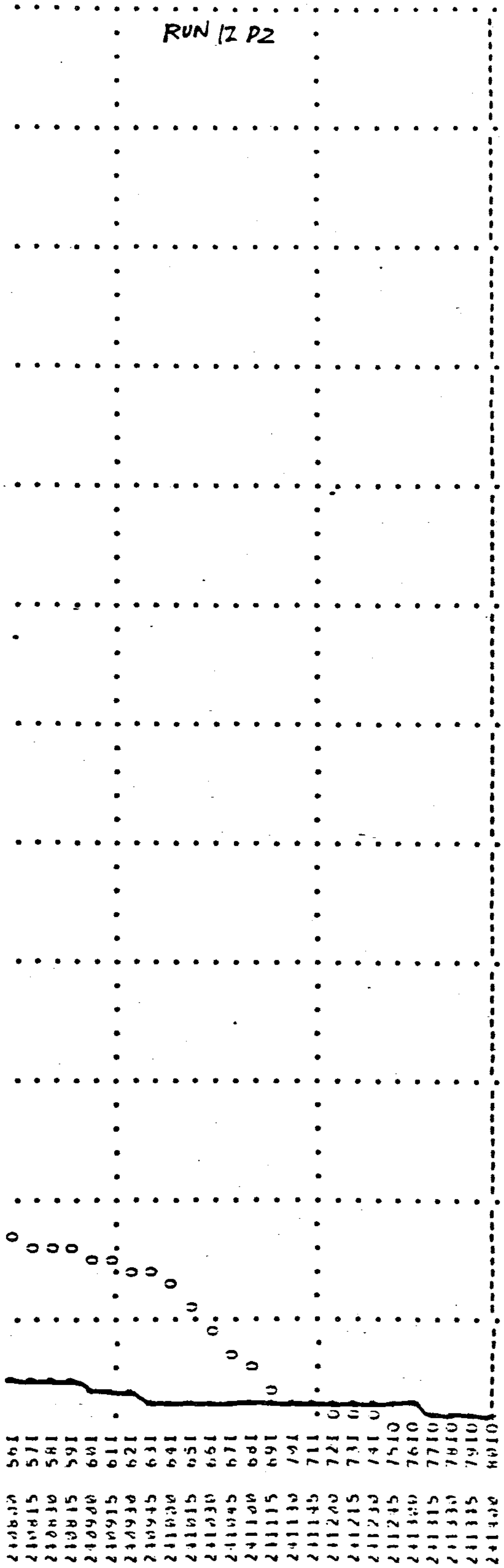
	Sum of flows	Time to center of mass	peak flow	Time of peak	Mean Flow
Comp.	38339	9.03	1283	8.00	479
Obs.	27370	7.25	1149	6.75	342
Diff.	10969	1.78	134	1.25	137
% Diff.	40.08		11.65		

Ave. % Abs. error = 124.02 %

Ave. Abs. error = 250

Standard Error = 339




561
571
581
591
601
611
621
631
641
651
661
671
681
691
701
711
721
731
741
751
761
771
781
791
801
240800
240815
240830
240845
240900
240915
240930
240945
241000
241015
241030
241045
241100
241115
241130
241145
241200
241215
241230
241245
241300
241315
241330
241345
241400

RUN 12 P2

RUN 13 P1

	Sum of Flow	Time to Centre of mass	Peak flow	Time to peak
Computed	32433	8.79	1160	8.25
Observed	27370	7.25	1149	6.75
Diff.	5063	1.54	11	1.50
% Diff	18.50		0.94	
AVE % ABS Error	92.91 %			

data Same as TEST 10. except Tc's are changed

A 0.65→0.45

B_I 0.35→0.2

B_P 0.55→0.42

H_I 0.42→0.3

H_P 0.64→0.45

J_I 0.25→0.1

J_P 0.4→0.25

I_I 0.45→0.2

I_P 0.55→0.3

M_I 0.35→0.15

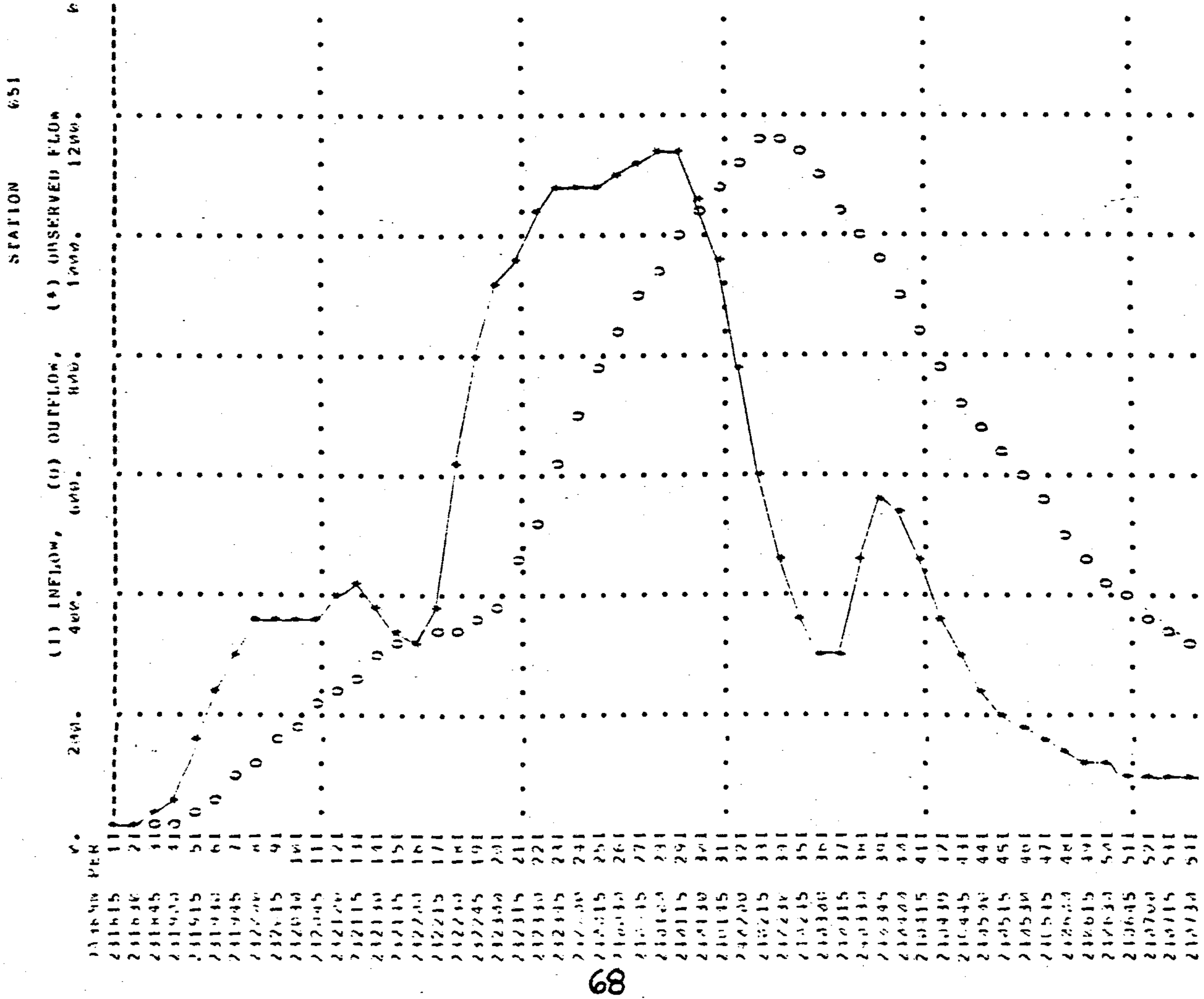
M_P 0.51→0.25

L_I 0.3→0.1

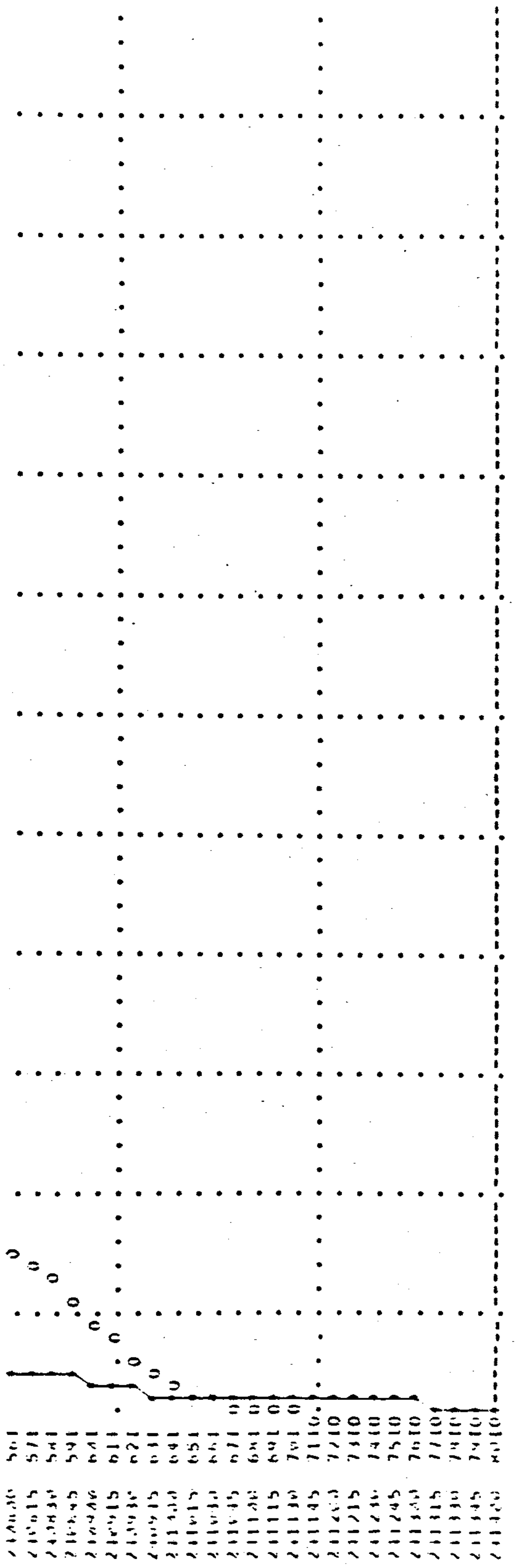
L_P 0.4→0.2

N_I 0.35→0.15

N_P 0.48→0.27



RIN13 P2

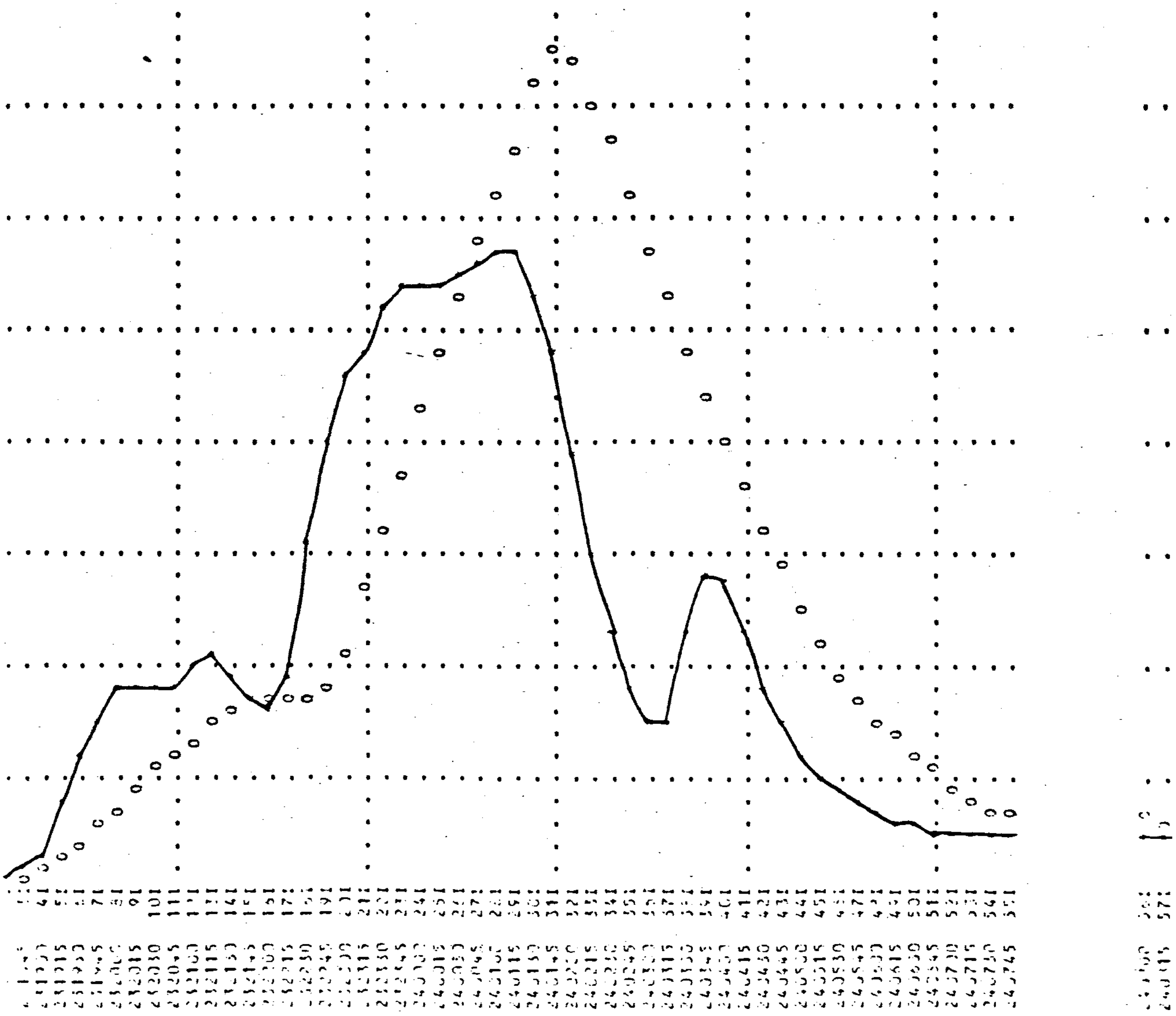


RUN 14 P1

	SUM of Flow	Time to Centroid Mass	peak Flow	Time to peak
Computed	32440	8.12	1492	7.50
Observed	27370	7.25	1149	6.75
Diff.	5070	0.87	343	0.75
% Diff	18.52		29.85	

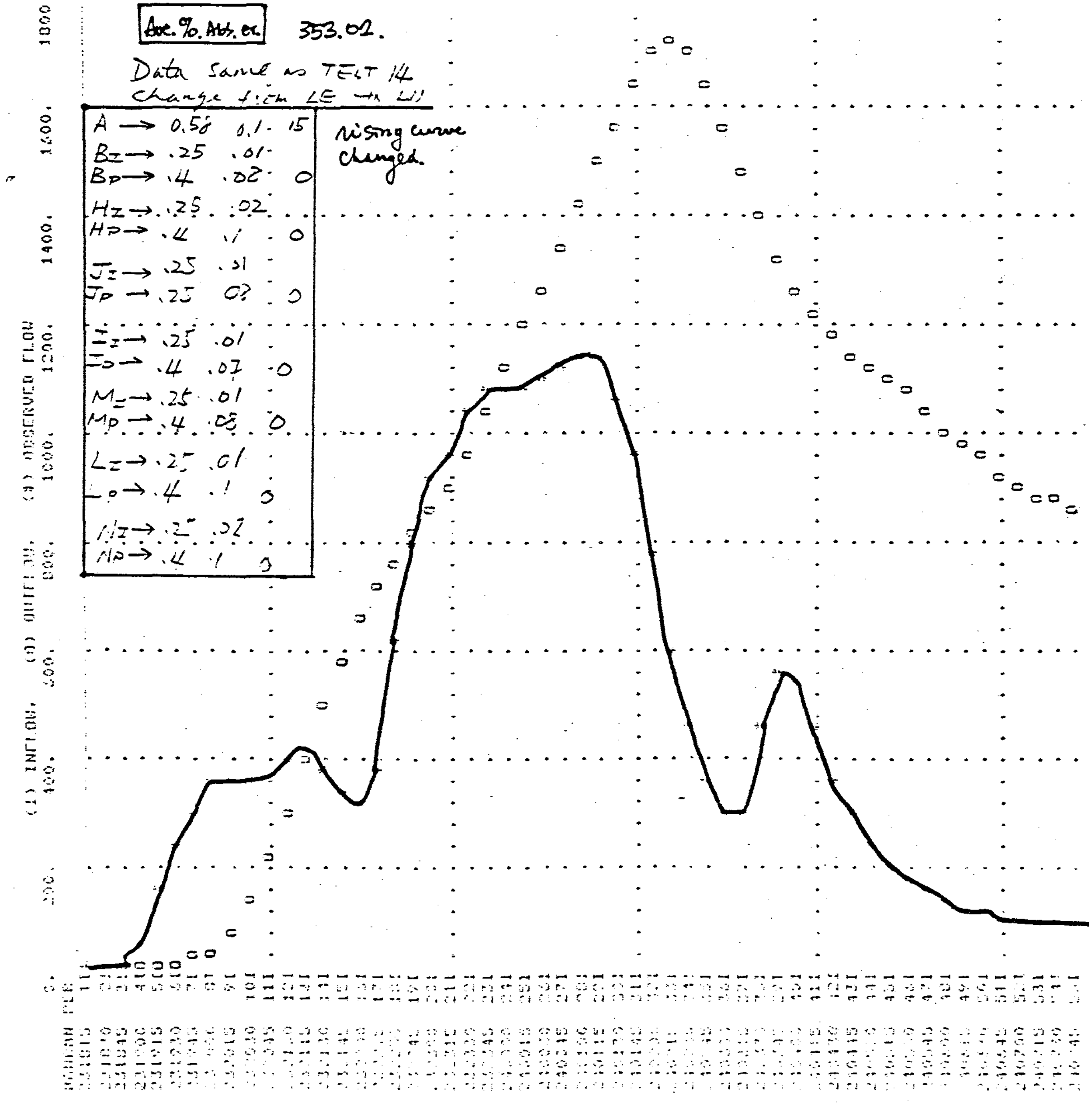
AVE % ABS. Err 60.00

Data same as TEST 14
Except Routing (pulo) through subarea B and H are not conducted.



RUN15 P1

	Sum of Flow	Time to Centroid of Flow	Peak Flow	Time to Peak
Computed	61992	10.16	1720	8.00
Observed	27370	7.25	1149	6.75
Diff	34622	2.91	571	
			49.72	
% Diff	126.5			

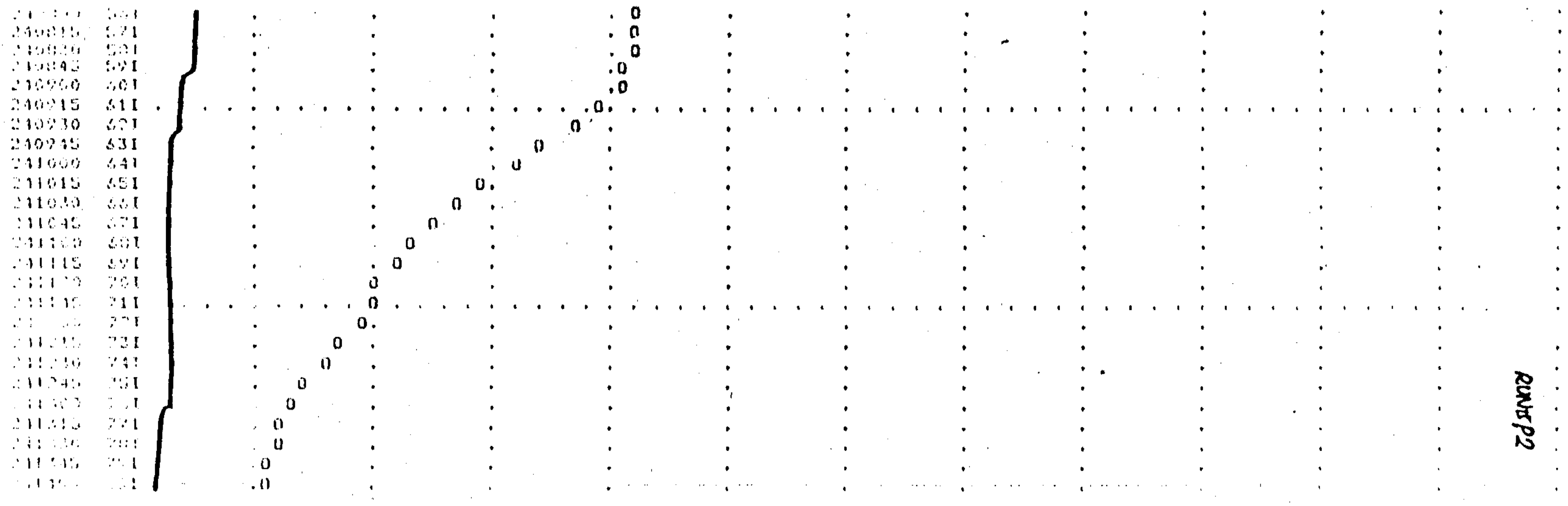


Ave. % Abs. er. 353.02.

Data same as TEST 14
change from LE to LU

A →	0.58	0.1	15
Bz →	.25	.01	
Bp →	.4	.02	0
Hz →	.25	.02	
Hp →	.4	.1	0
Jz →	.25	.01	
Jp →	.25	.02	0
Iz →	.25	.01	
Ip →	.4	.07	0
Mz →	.25	.01	
Mp →	.4	.05	0
Lz →	.25	.01	
Lp →	.4	.1	0
Nz →	.25	.02	
Np →	.4	.1	0

rising curve changed.

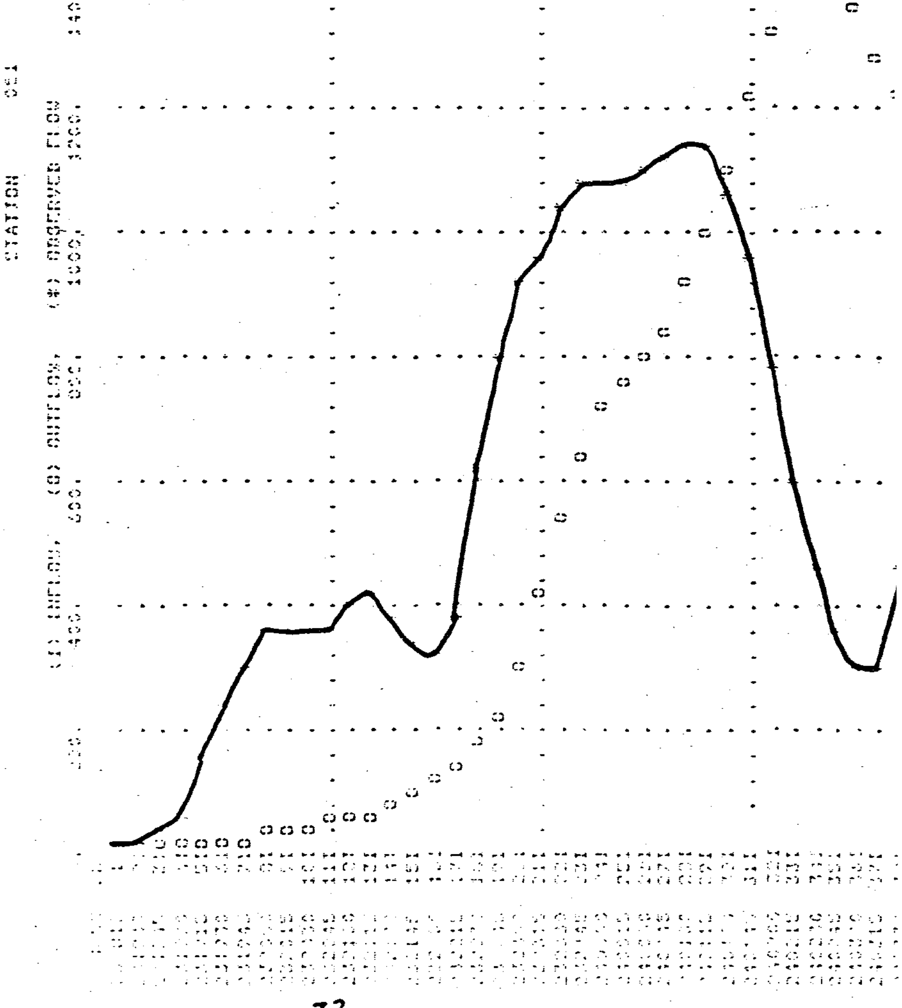

RUN5P2
240815 571
240830 581
240845 591
601
240915 611
240930 621
240945 631
241000 641
241015 651
241030 661
241045 671
681
241115 691
701
711
721
731
741
751
771

RUN 16 P1

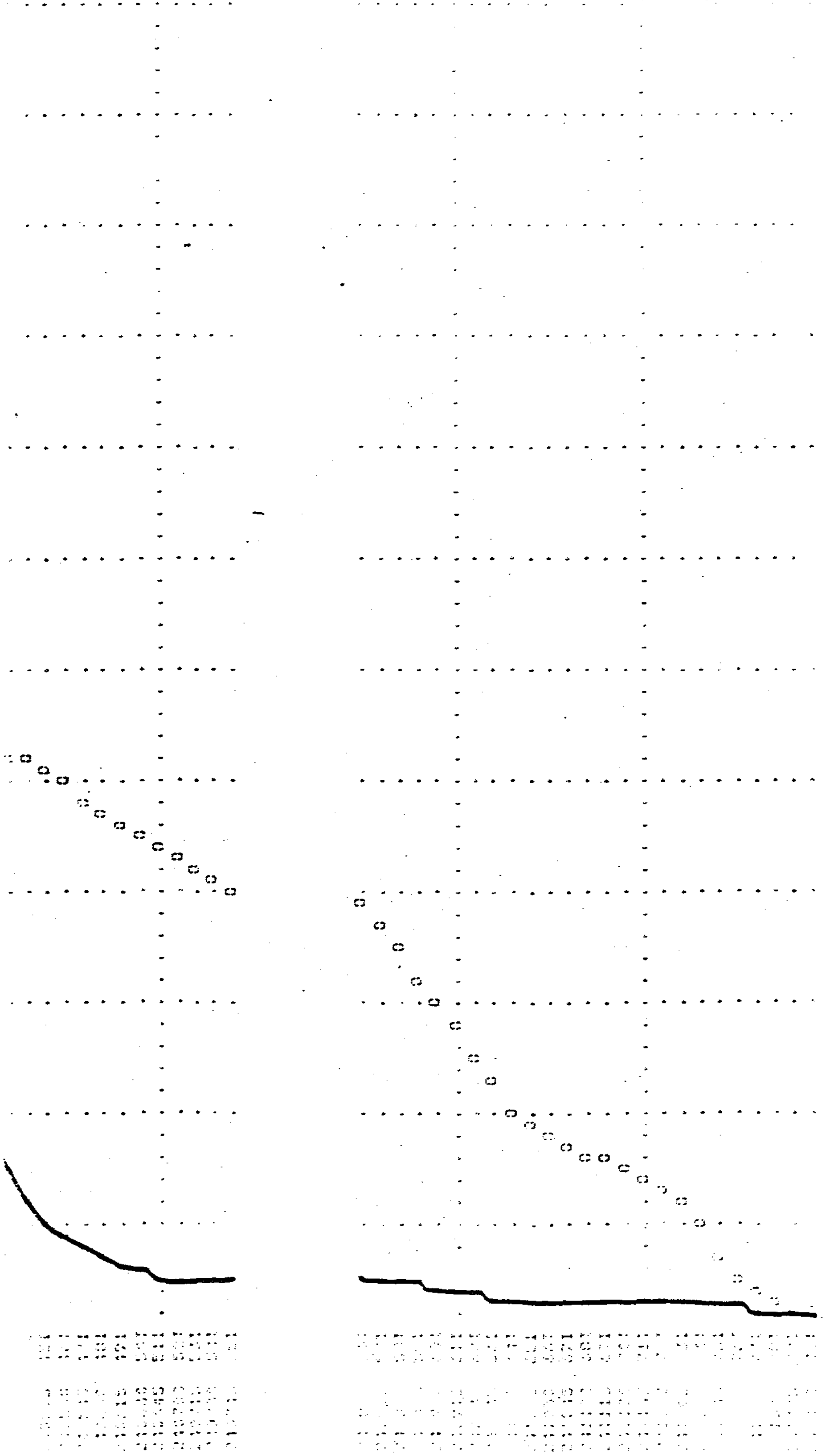
	SUM OF FLOWS	mean Flow	Time to C.M	Peak Flow	Time t Peak
Computed	45231	565	10.61	1433	8.25
Observed	27370	342	7.25	1149	6.75
Diff.	17861	223	3.36	204	1.50
Diff. %	65.26%			24.71%	

Standard Error.	516
Ave. Abs. Error	432
Ave. Abs. % Error	264.81.

Change from LE to LU.
detailed data not found.
Improved from previous run.
NOTE: rising curve shifted!



RUN #6 P2



Run 17 p1

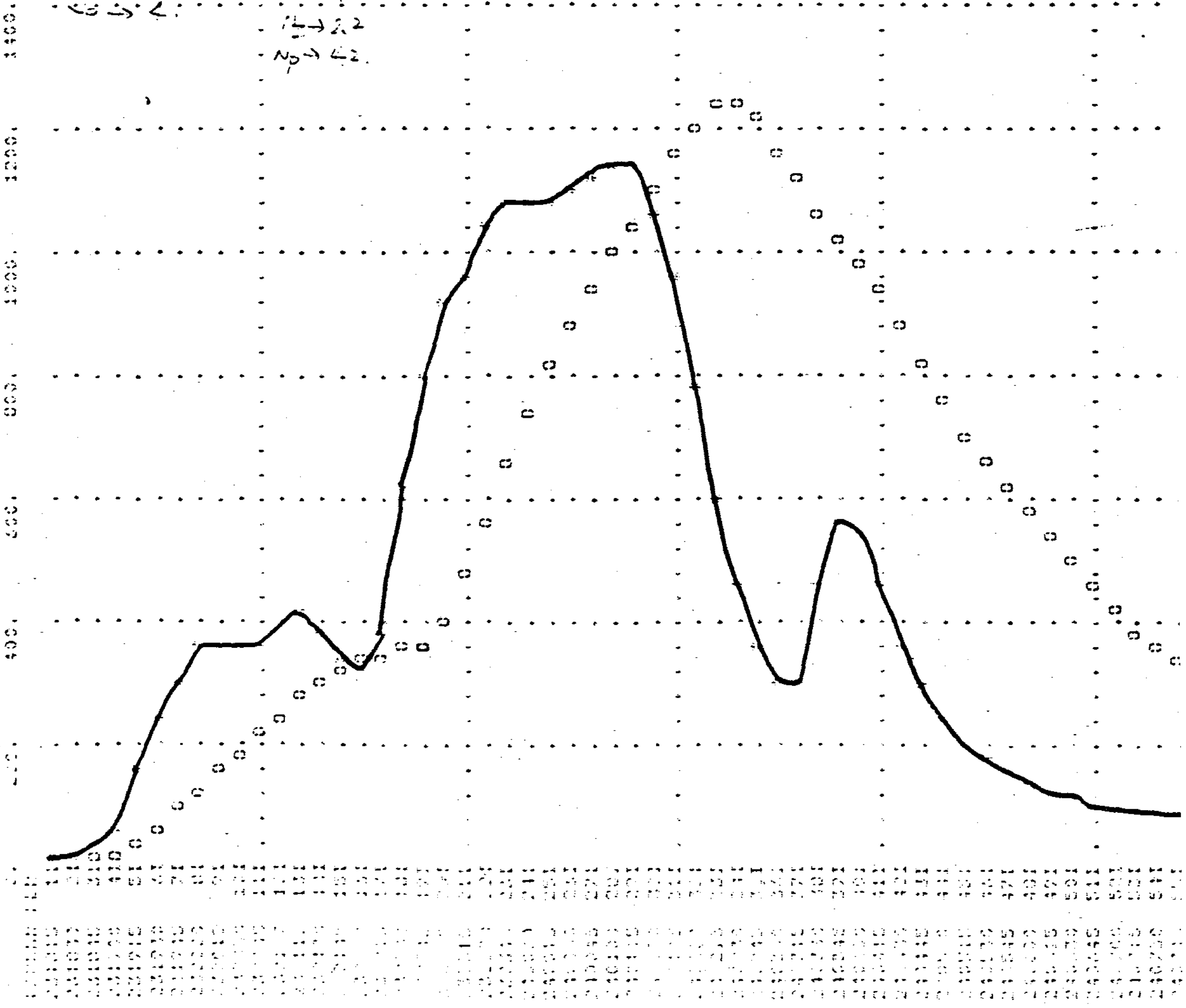
Computed	Sum of flow	Time to center of mass	peak Flow	Time of peak
	35394	8.90	1243	8.25
observed	27370	7.25	1149	6.75
diff	8024	1.74	94	1.50
diff%	2932		8.14	

Ave % Abs. Error 110.26%

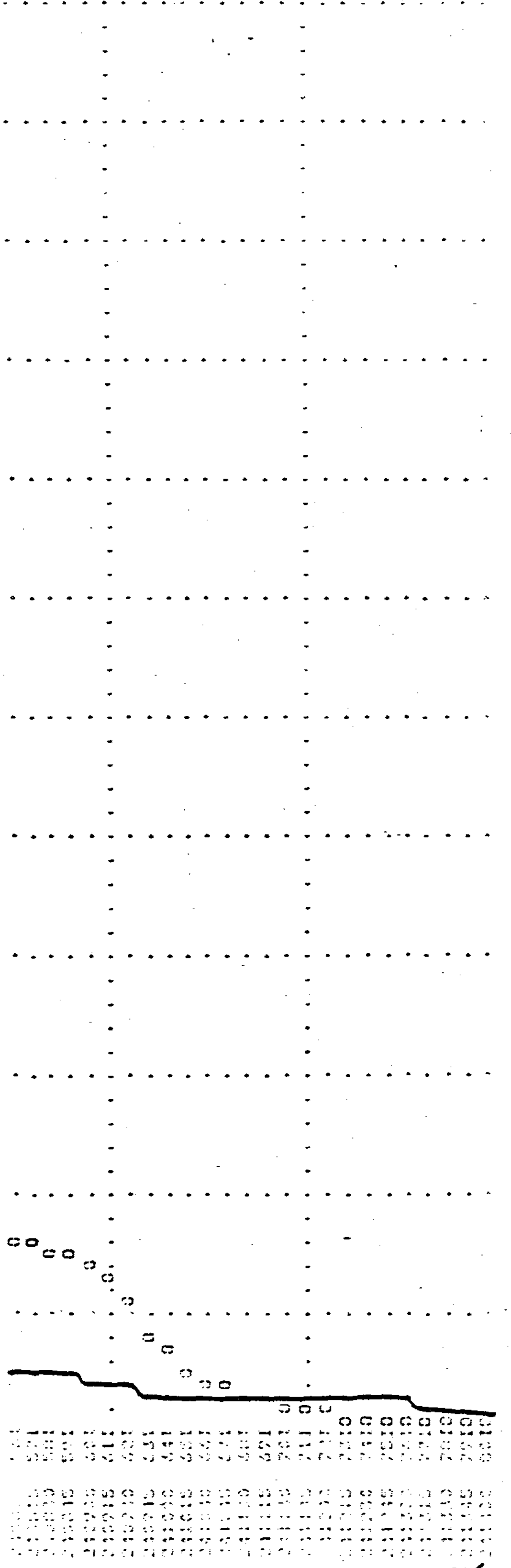
Data Same as Test 14

The parameters changed in LE card RTIOR

B_z → 2.5
B_o → 4.2
I_z → 2.2
I_o → 4
H_z → 2.2
H_p → 4
M_z → 2.7
M_p → 4.2
C_z → 2.4
C_o → 4.
L_z → 2.
L_o → 4.2
N_z → 2.2
N_p → 4.2.



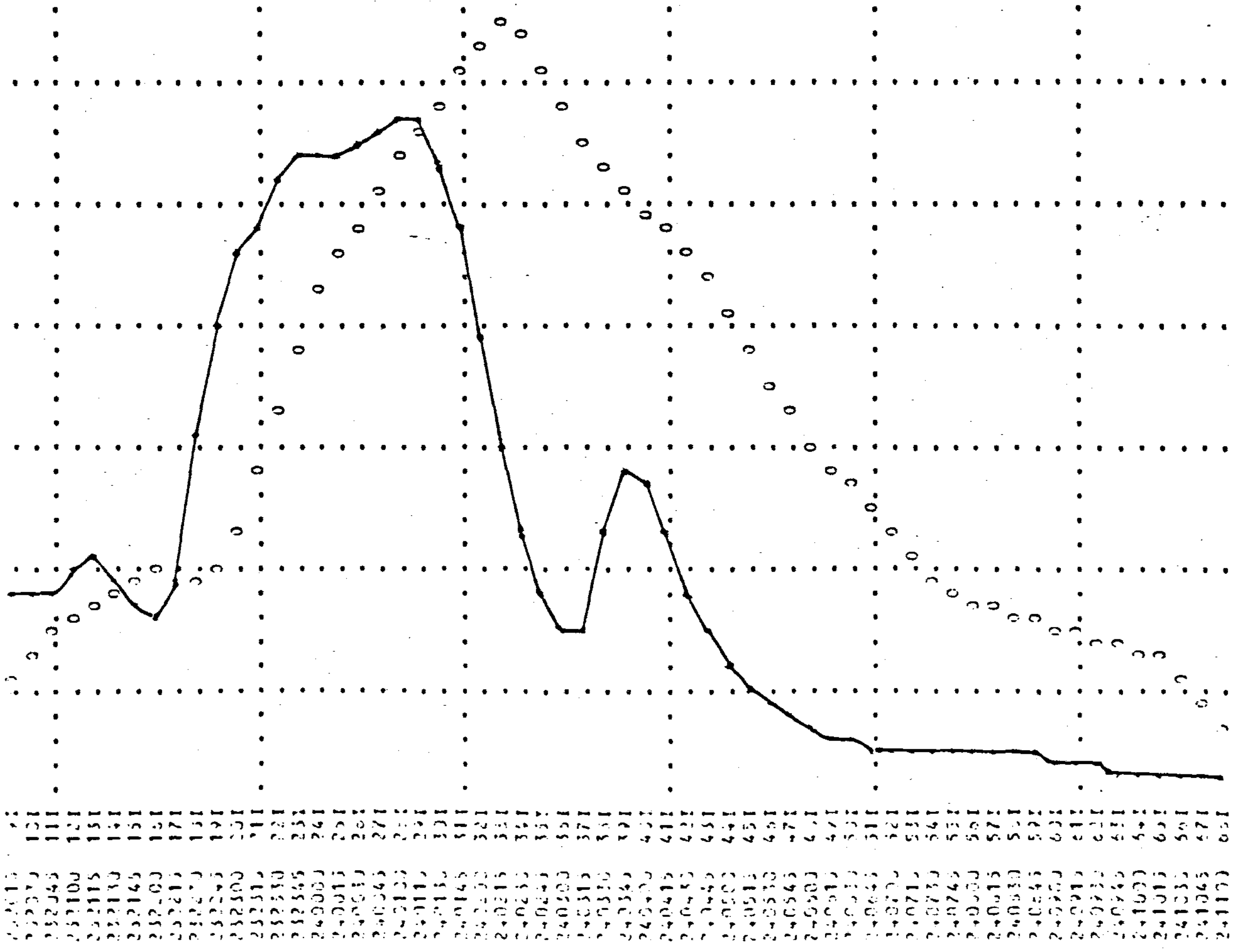
RUN 17 p2



Run 18 P1

	Sum of flow.	Time to Center of mass	Peak flow	Time of peak.
Computed	39184	9.05	1295	8.00
Observed	27370	7.25	1149	6.75
diff.	11814	1.80	146	1.25
diff. %	43.16		12.67%	
Ave. % Abs. error	129.34%			

Tc same as TEST 14
R same as TEST 12

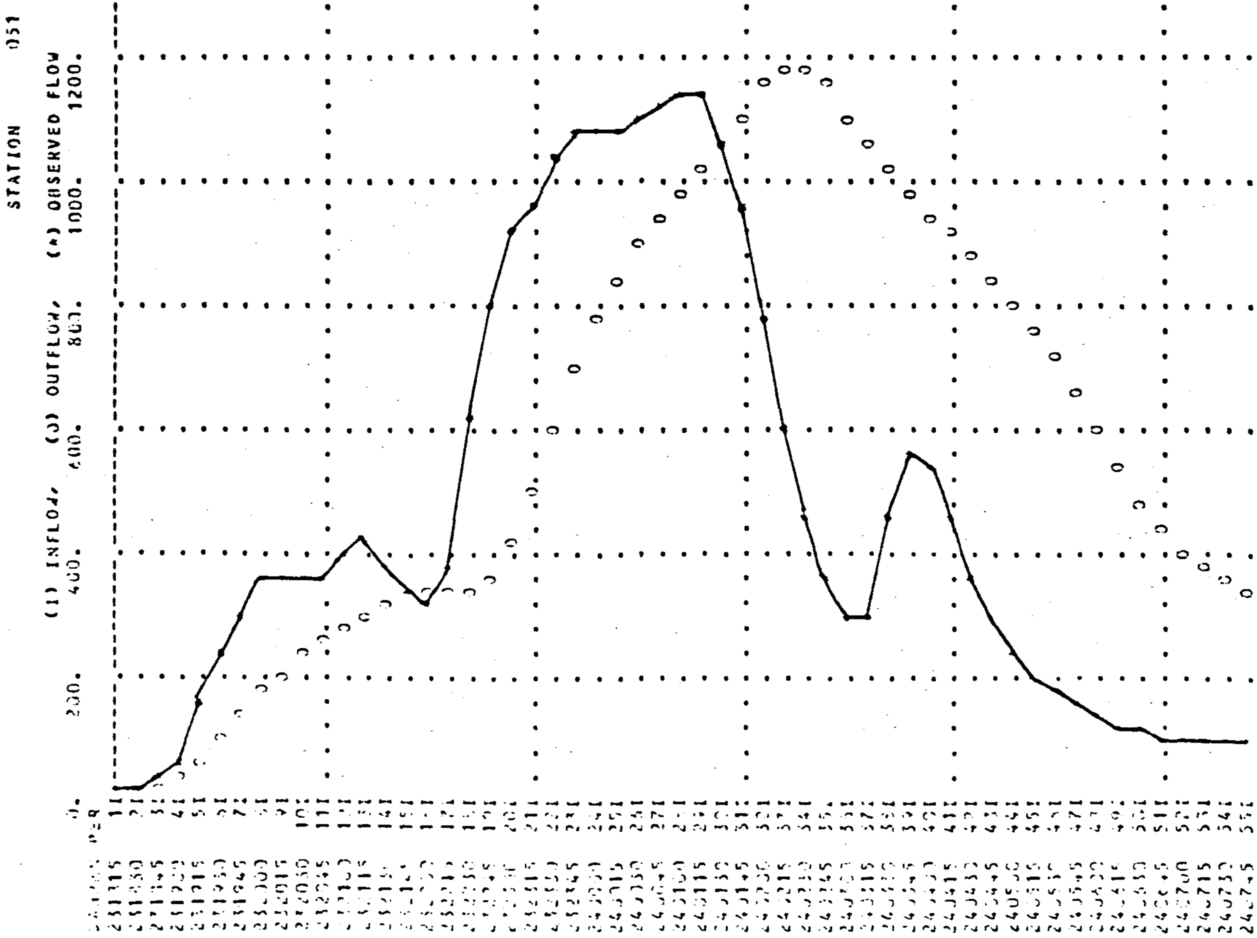


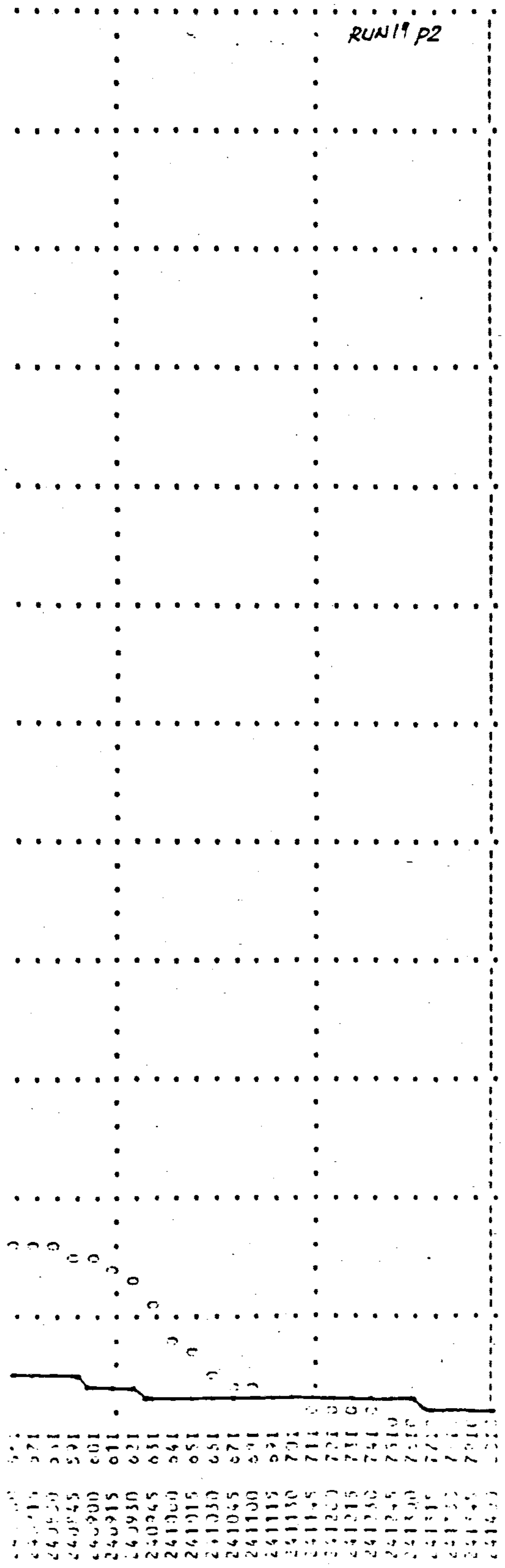
RUN 9. P1

	Sum of flow	Time to center of mass	peak Flow	Time of Peak	mean Flow
Computed	35952	8.97	1189	8.25	449
Observed	27370	7.25	1149	6.75	342
Diff.	8582	1.72	40	1.50.	107
Diff %.	31.36		3.49		

Ave. % ABS. Error = 111.31%
Ave. Abs. Error = 238
Standard Error = 320

Data enclosed.
1 change loss Rate from TEST 19. → loss more on hill area (A, B, H) porvi
less on L.M.N.
2 Also get back to TEST 10's Tc.




RUN 19 P2

RUN 20 PI

	Sum of flows	mean Flow	Time to Center of mass	Peak Flow	Time of Peak
Computed	27395	342	7.88	1177	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	25	0	0.63	28	1.25
% of Diff.	0.09		0.73	2.47	

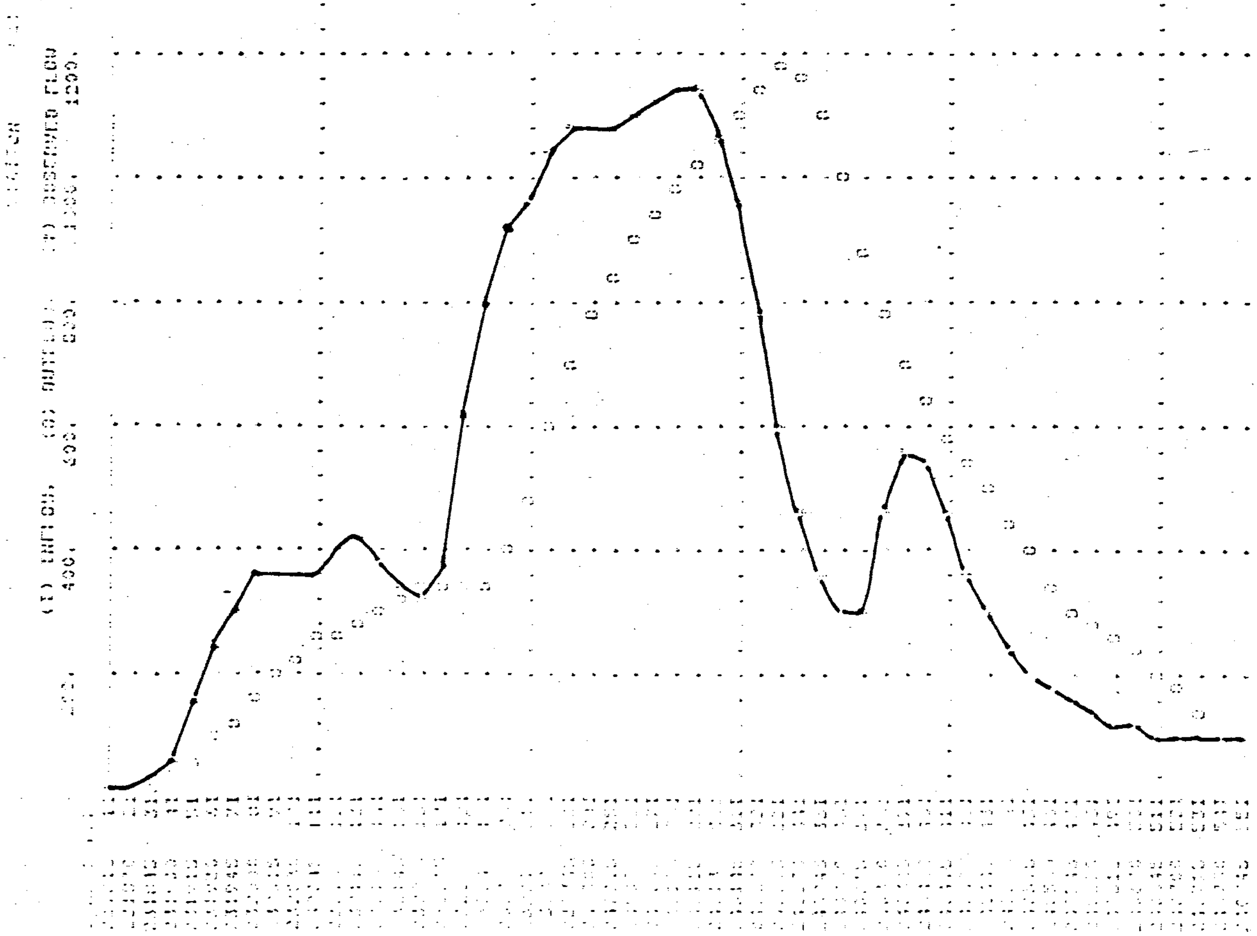
Ave. % ABS. error 60.38 %

Ave. Abs. error 155

standard error 233

Changes: Change the parameter RTIOR of BF
Subarea A : → 6.5
Impervious part of other Subareas : → 3.5
pervious " → 7.5

Based on data of the last run



RUN 21 PI

	Sum of flows	mean flow	Time to Center of Mass	Peak flow	Time of peak
Computed	27395	342	7.88	1191	8.00
observed	27370	342	7.25	1149	6.75
Diff.	25	0	0.63	42	1.25
% of Diff.	0.09			3.66	

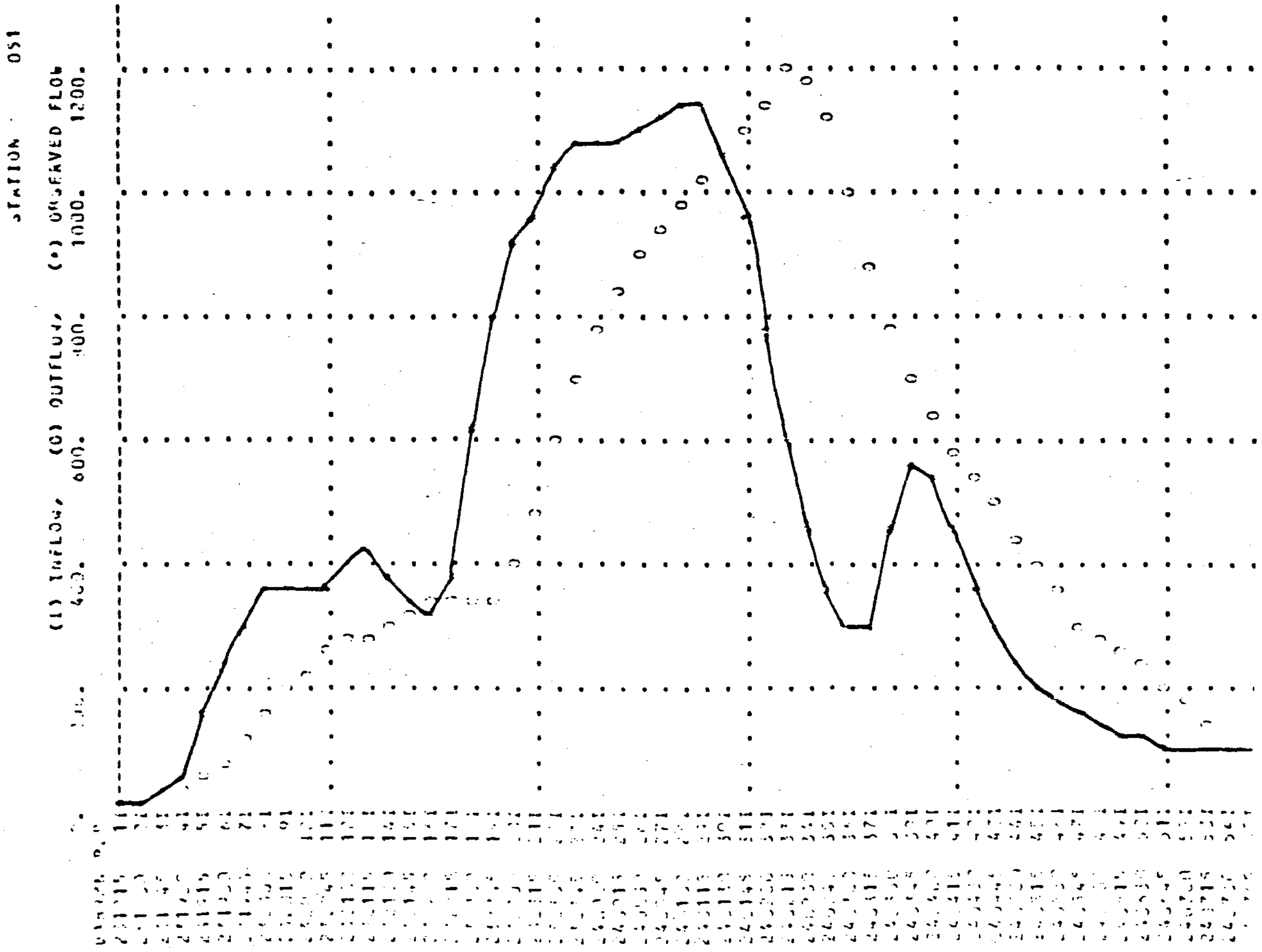
Ave. % ABS. error 60.67%

Ave. Abs. error 156

Standard error 235

Changes: All X of Muskingum routing changed from 0.1 → 0.3

Based on data of last run



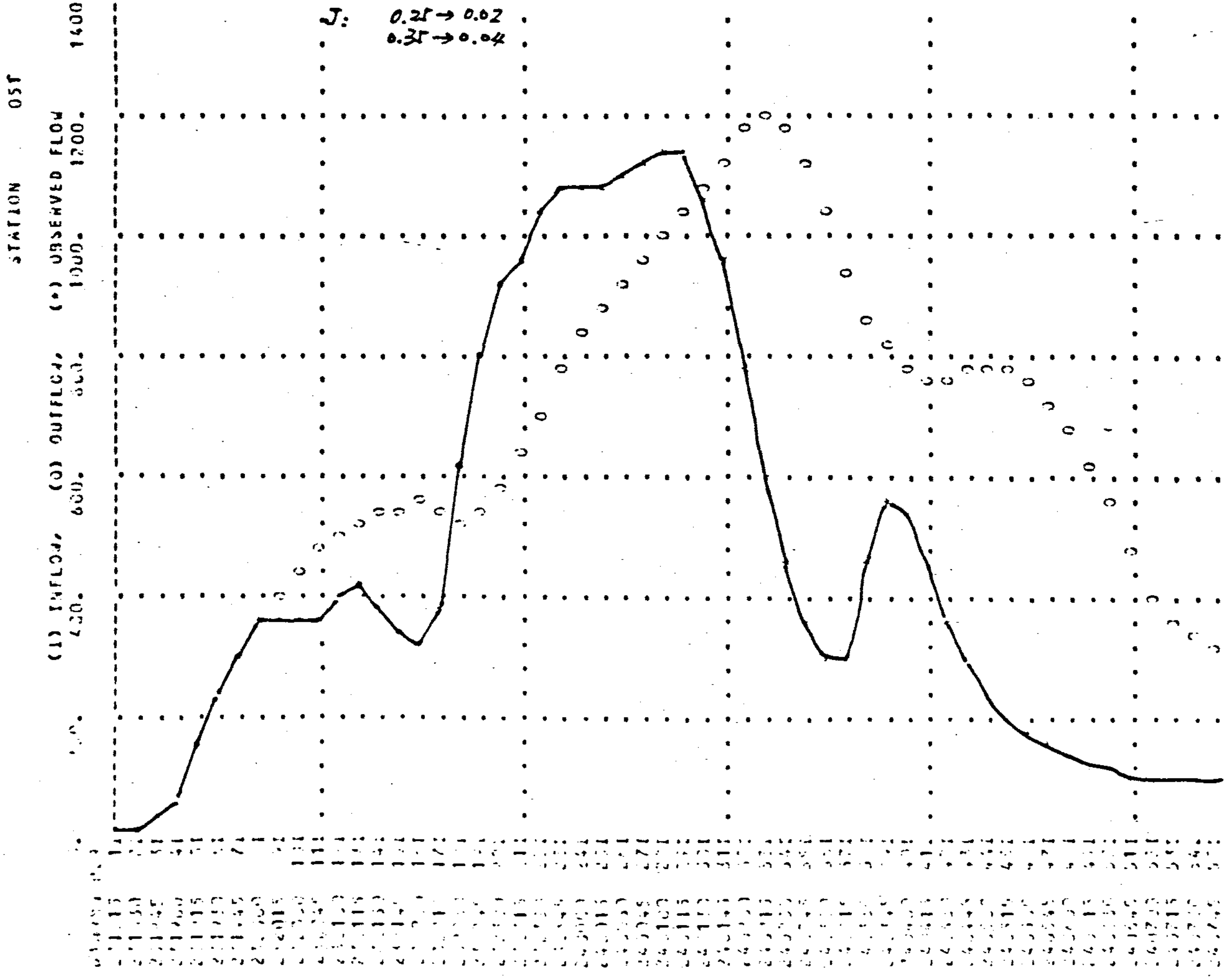
RUN22D1

	Sum of flows	mean flow	Time to Center of Mass	peak Flow	Time of Peak
Computed	37053	463	8.12	1204	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	9683	121	0.87	55	1.25
% of Diff.	35.38			4.75	

Ave. % ABS. error	103.73 %	Ave. Abs. Error	209	Standard error	291

Changes : Changes the loss Rate parameters of impervious part of subareas B~N.

STRKR	B: 0.2 → 0.03	M: 0.25 → 0.02
DLTKR	0.4 → 0.05	0.4 → 0.05
	H: 0.2 → 0.03	L: 0.25 → 0.02
	0.43 → 0.07	0.32 → 0.04
	I: 0.3 → 0.02	N: 0.25 → 0.02
	0.42 → 0.05	0.36 → 0.05
	J: 0.25 → 0.02	
	0.35 → 0.04	



RUN 23 P1

	Sum of flows	mean flow	Time to center of mass	peak flow	Time of peak
Computed	30465	381	7.48	1177	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	3095	39	0.23	28	1.25
%. of Diff.	11.31			2.47	

Ave. % ABS. error	58.61 %	Ave. Abs. error	150	Standard Error	232

Changes: Changed the loss rate parameters of pervious part of subareas B~N.

STRKR
DLTKR

B: 0.5 → 0.8
0.85 → 1.59

H: 0.5 → 0.8
0.9 → 1.98

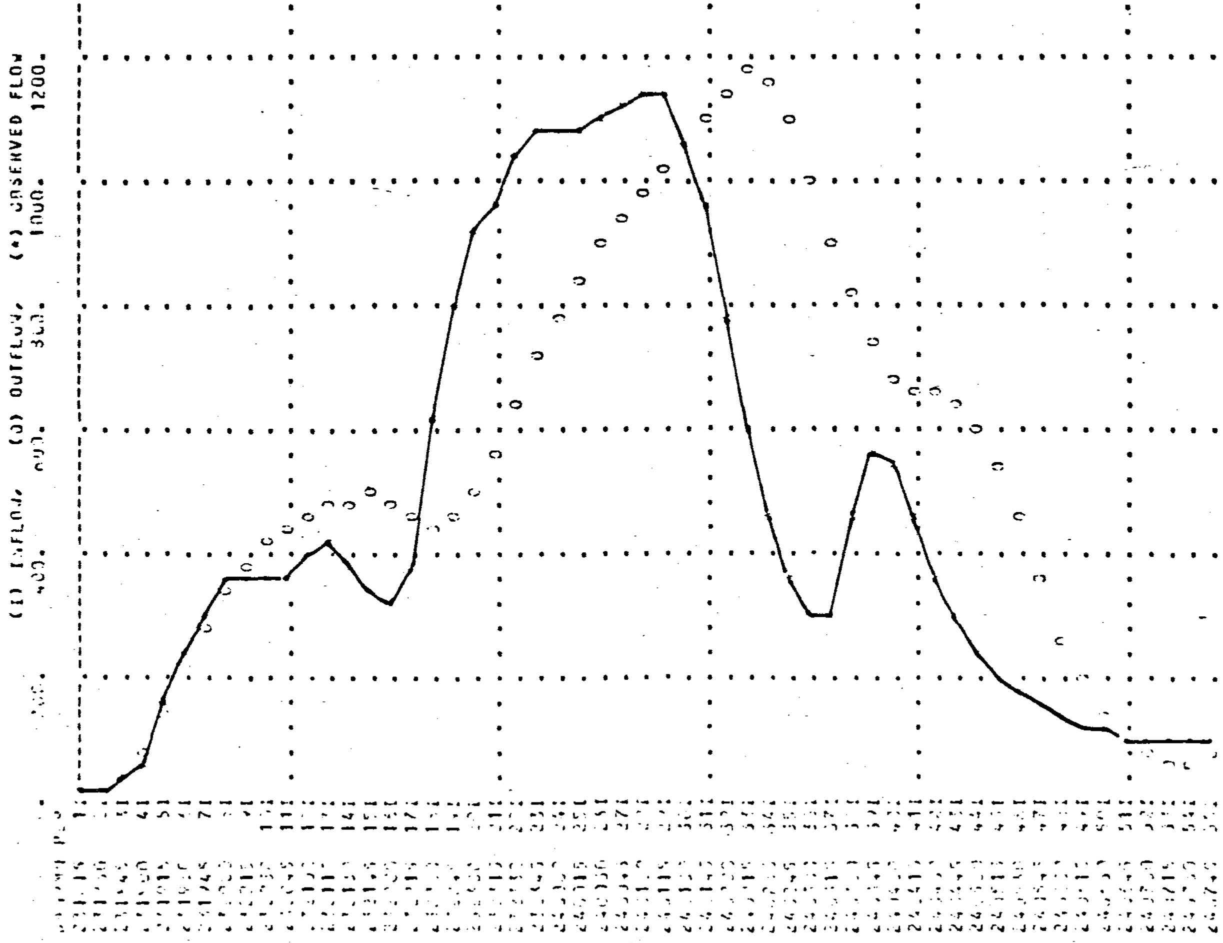
I: 0.35 → 0.6
0.65 → 1.36

J: 0.44 → 0.6
0.55 → 1.4

M: 0.35 → 0.6
0.47 → 1.45

L: 0.35 → 0.5
0.5 → 1.32

N: 0.35 → 0.6
0.5 → 1.32



RUN 24 P1

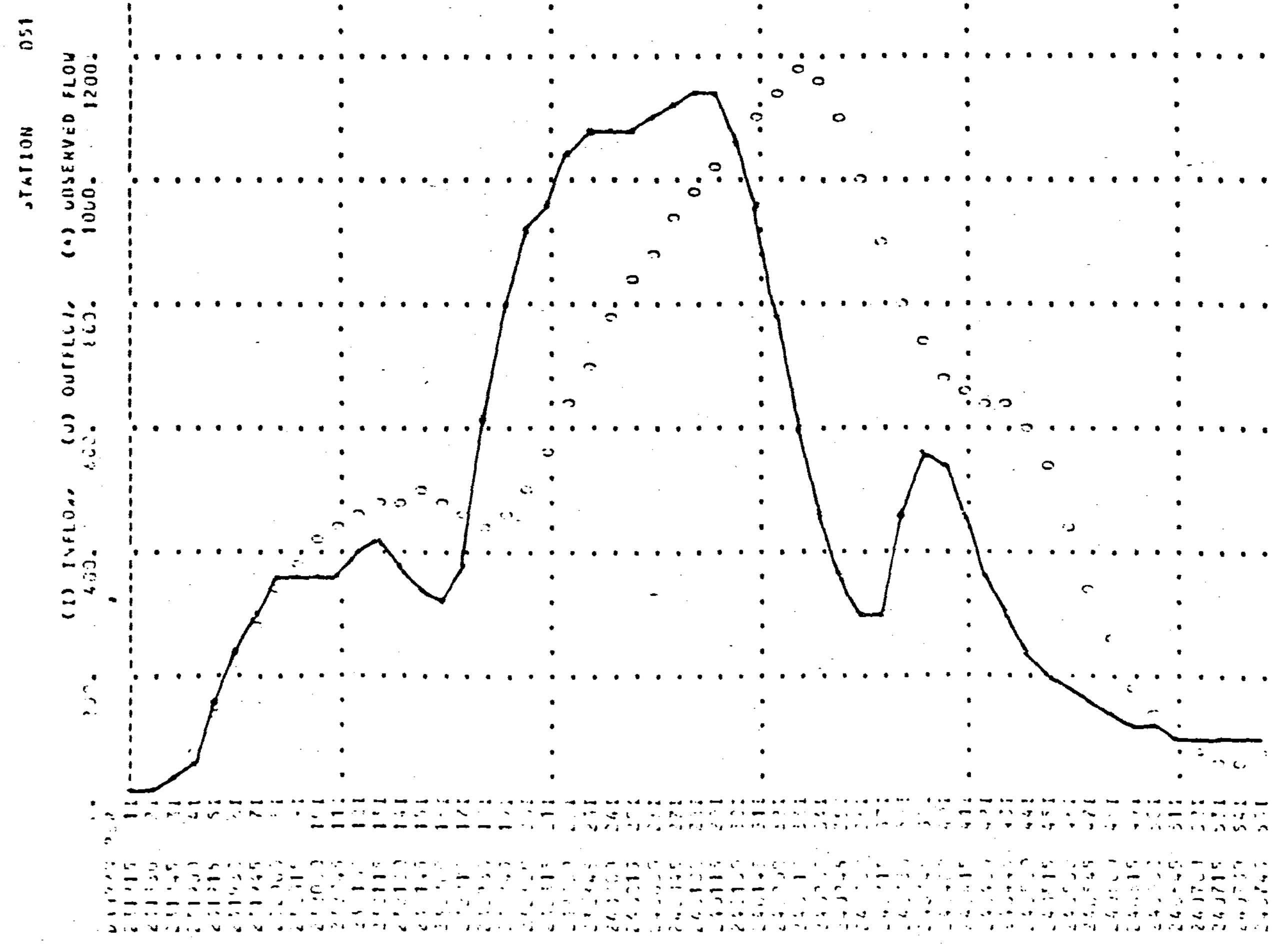
	Sum of Flows	mean Flow	Time to Center of mass	peak Flow	Time of peak
Computed	30223	378	7.46	1171	8.00
Observed	27370	342	7.25	1149	6.75
Diff	2853	36	0.21	22	1.75
% of Diff.	10.42			1.88	

Ave. % Abs. error	57.93%	Ave. Abs. error	149	Standard Error	231

Changes : 1. Changed the loss rate parameters again only of subarea B & H's pervious part.

B : STRKR No change
DLTKR 1.59 → 1.85
H: DLTKR 1.98 → 2.31

2. Also the ERAINs
A: 0.25 → 0.2
B: 0.35 → 0.25
H: 0.35 → 0.25

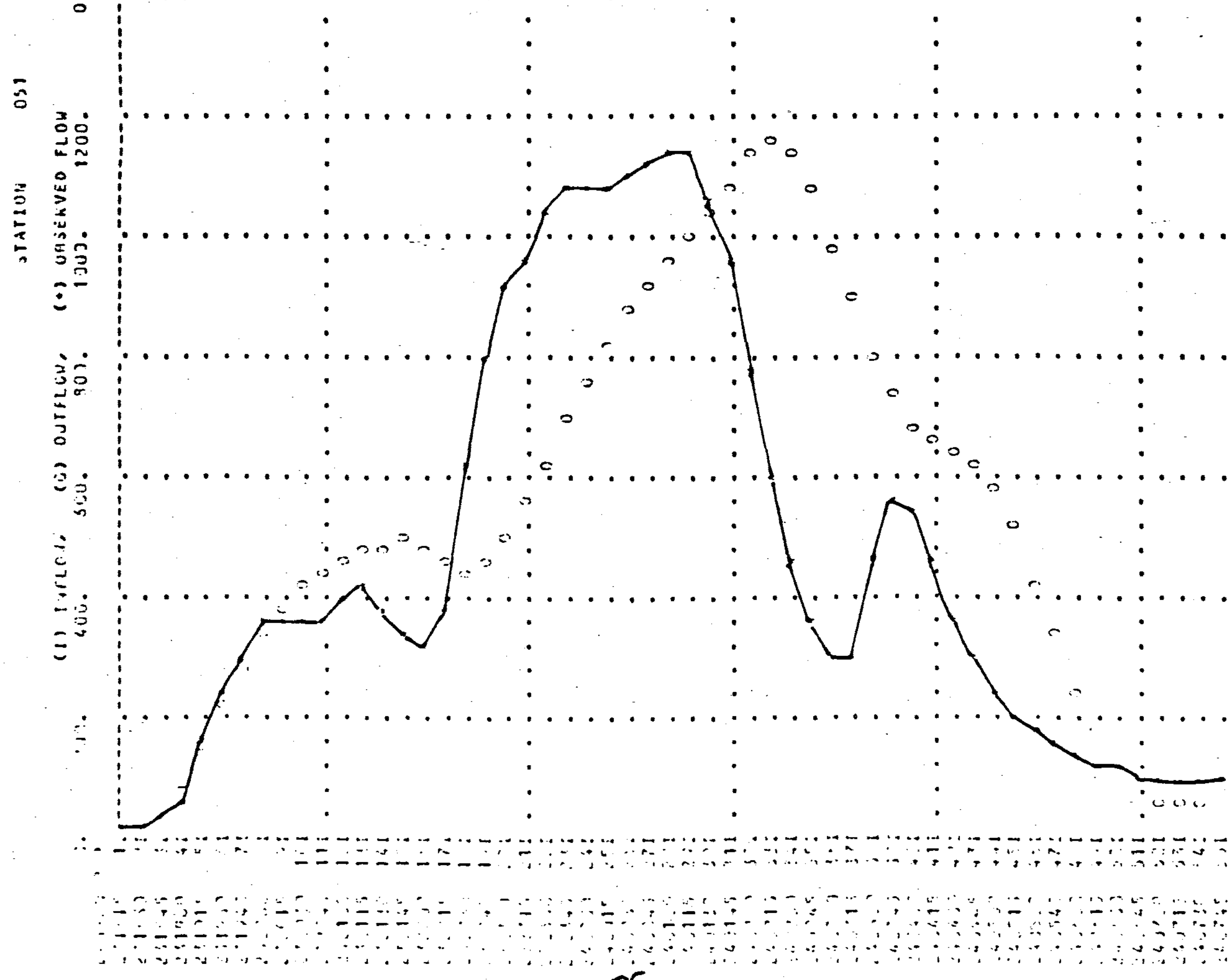


RUN 25 P1

	Sum of flows	Mean Flow	Time to Center of Mass	Peak Flow	Time to Peak
Computed	29915	374	7.44	1158	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	2545	32	0.20	9	1.25
% of Diff.	9.30			0.78	

Ave. % Abs. error	57.47 %	Ave. Abs. error	149	Standard Error	229

Changes:
1. Loss rate parameters STRKR & DLTKR of area A changed from 0.68 → 0.7 and 1.2 → 1.5 respectively.
2. ERAIN changed back, i.e. A: 0.2 → 0.25
B: 0.25 → 0.35
H: 0.25 → 0.35
3. Subareas I, J, M, N, L change ERAIN.
Impervious part, 0.2 → 0.15
Pervious part, 0.35 → 0.25.



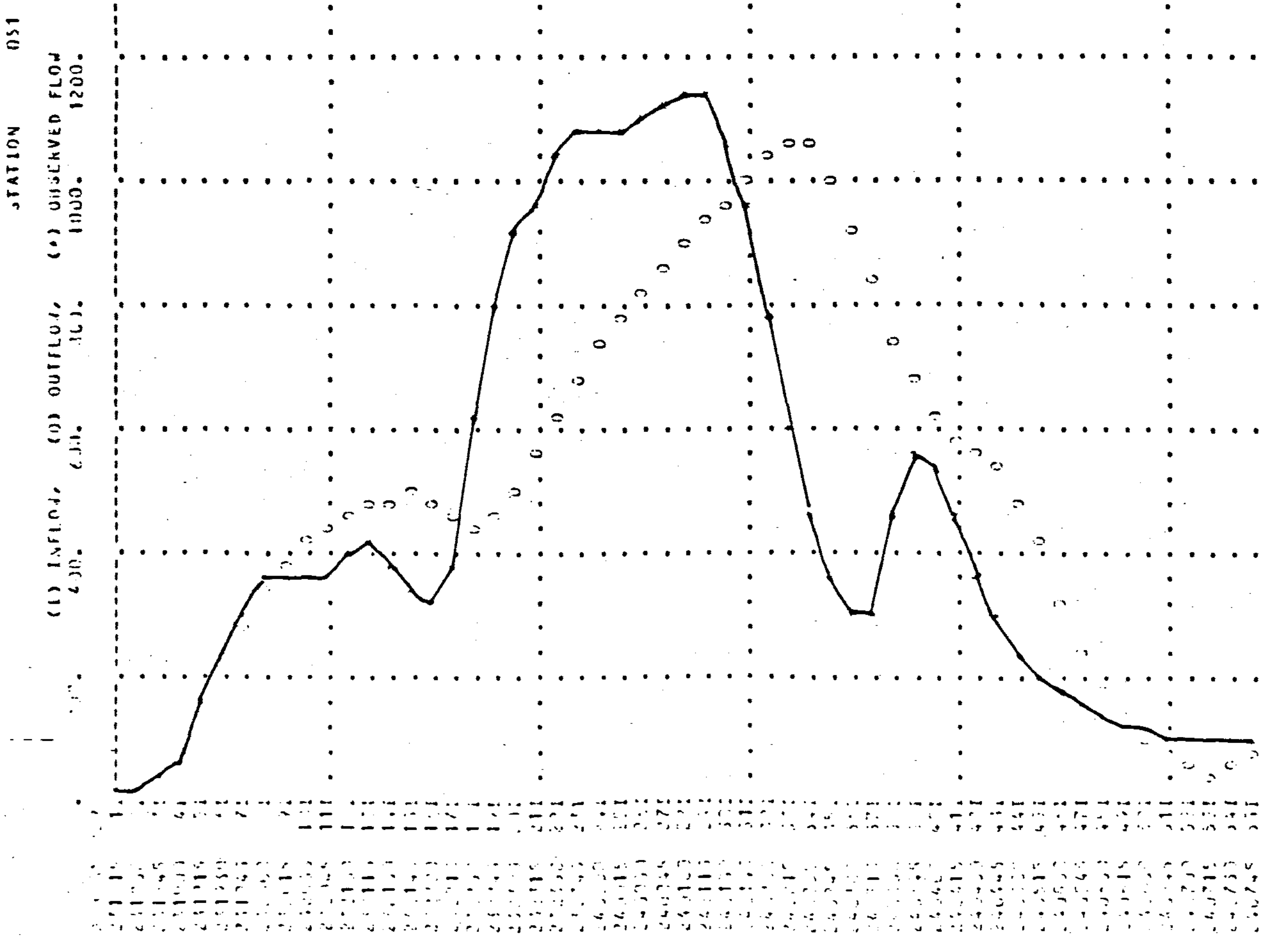
RUN 26 ·P1

STORM1

	Sum of Flow	Mean Flow	Time to Center of Mass	Peak Flow	Time Peak
Computed	27963	350	7.31	1064	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	593	7	0.07	-85	1.25
% of diff.	2.17			-7.41	

Ave. % Abs. error	≤2.34%	Ave. Abs. error	137	Standard Error	209

Changes:
B_p STRKR, 0.8→1.0
Hp " 0.8→1.0
A " 0.7→0.8

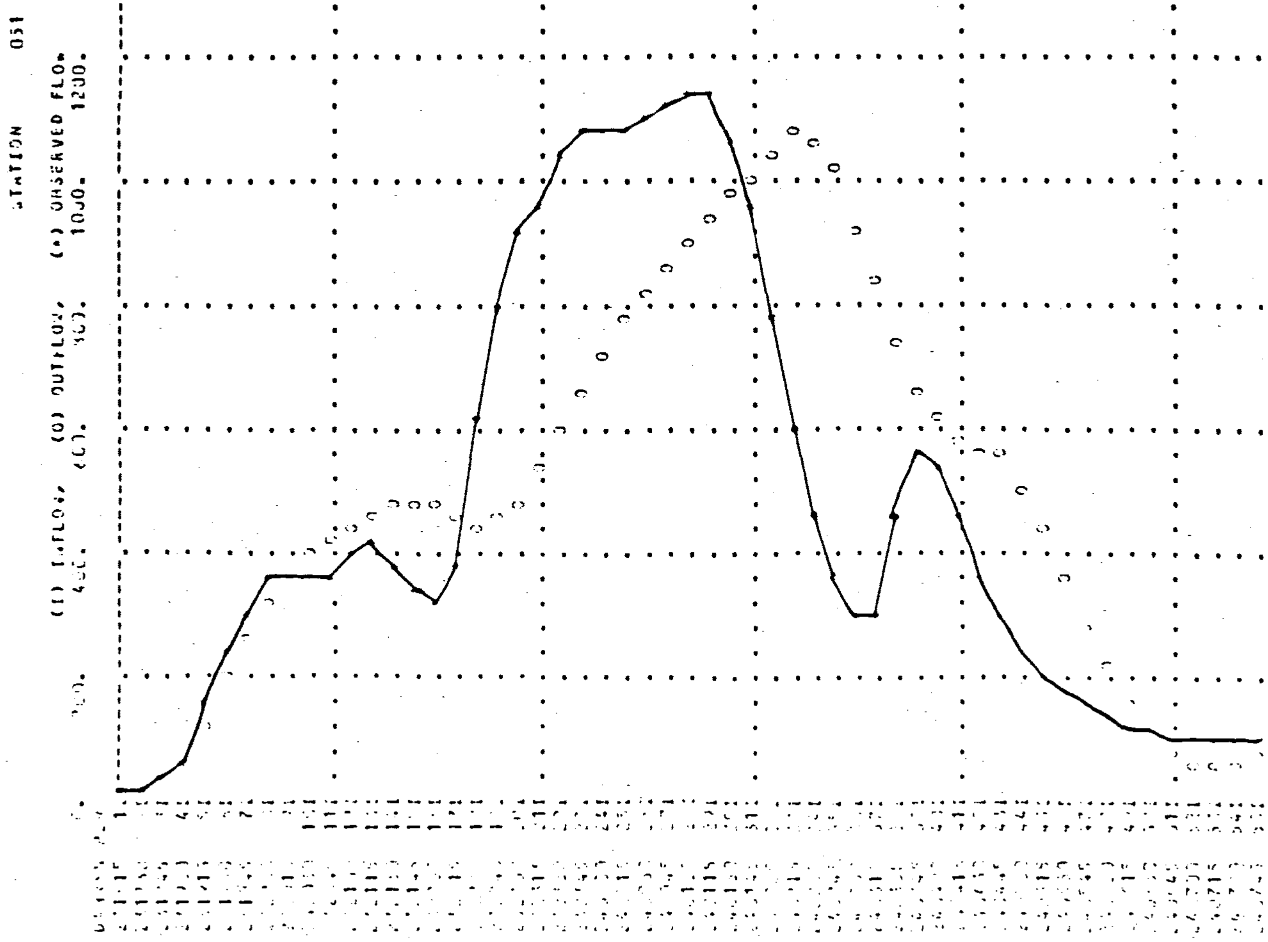


RUN# P1

STORM 1	Sum of flows	mean Flow	Time to Center of mass	peak Flow	Time of Peak
Computed	27970	350	7.40	1075	8.06
Observed	27370	342	7.25	1149	6.75
Diff.	600	7	0.15	-74	1.25
% of Diff.	2.19%			-6.45%	

Ave. % Abs Error 52.60 %   Ave. Abs. Error 139   STANDARD Error 212

Change : storage - discharge relationship adjusted to 100% of the data from previous report (before, we use only 80%).



```
  *      OBSERVED HYDROGRAPH         27370.     1.085            342.      7.25        7.25         1149.      6.75     *
  *                                                                                                                    *
  *      DIFFERENCE                  -3778.    -0.150            -47.     -0.05       -0.05         -142.      1.25     *
  *      PERCENT DIFFERENCE          -13.80                                           -0.65        -12.33               *
  *                                                                                                                    *
  *                    STANDARD ERROR      193.                   AVERAGE ABSOLUTE ERROR      118.                      *
  *                OBJECTIVE FUNCTION      245.           AVERAGE PERCENT ABSOLUTE ERROR     44.22                      *
  *                                                                                                                    *
  **********************************************************************************************************************

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                                            HYDROGRAPH AT STATION      051

***************************************************************************************************************************
                                              *                                            *
 DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL  * DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL * DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL
                                              *                                            *
 23 JAN 1815   1       18.      22.      -4.  * 24 JAN 0100  28      852.    1149.    -297. * 24 JAN 0745  55       84.     107.      -23.
 23 JAN 1930   2       18.      22.      -4.  * 24 JAN 0115  29      898.    1134.    -236. * 24 JAN 0800  56      105.     107.       -2.
 23 JAN 1345   3       26.      32.      -6.  * 24 JAN 0130  30      937.    1067.    -130. * 24 JAN 0815  57      116.     102.       14.
 23 JAN 1900   4       55.      57.      -2.  * 24 JAN 0145  31      970.     964.       6. * 24 JAN 0830  58      114.      90.       24.
 23 JAN 1915   5      106.     150.     -44.  * 24 JAN 0200  32      998.     772.     226. * 24 JAN 0845  59      102.      90.       12.
 23 JAN 1930   6      163.     234.     -66.  * 24 JAN 0215  33     1007.     608.     399. * 24 JAN 0900  60       85.      81.        4.
 23 JAN 1945   7      226.     299.     -73.  * 24 JAN 0230  34      972.     469.     503. * 24 JAN 0915  61       66.      81.      -15.
 23 JAN 2000   8      272.     355.     -83.  * 24 JAN 0245  35      884.     365.     519. * 24 JAN 0930  62       50.      77.      -27.
 23 JAN 2015   9      313.     359.     -46.  * 24 JAN 0300  36      763.     301.     462. * 24 JAN 0945  63       36.      67.      -31.
 23 JAN 2030  10      349.     352.      -3.  * 24 JAN 0315  37      637.     301.     336. * 24 JAN 1000  64       26.      67.      -41.
 23 JAN 2045  11      377.     369.       8.  * 24 JAN 0330  38      529.     460.      69. * 24 JAN 1015  65       19.      67.      -48.
 23 JAN 2100  12      396.     405.      -9.  * 24 JAN 0345  39      455.     567.    -112. * 24 JAN 1030  66       14.      65.      -51.
 23 JAN 2115  13      403.     414.      -6.  * 24 JAN 0400  40      412.     538.    -126. * 24 JAN 1045  67       10.      61.      -51.
 23 JAN 2130  14      410.     384.      26.  * 24 JAN 0415  41      383.     458.     -75. * 24 JAN 1100  68        7.      59.      -52.
 23 JAN 2145  15      406.     331.      75.  * 24 JAN 0430  42      348.     365.     -17. * 24 JAN 1115  69        5.      59.      -54.
 23 JAN 2200  16      399.     312.      87.  * 24 JAN 0445  43      314.     299.      15. * 24 JAN 1130  70        4.      59.      -55.
 23 JAN 2215  17      391.     388.       3.  * 24 JAN 0500  44      273.     245.      28. * 24 JAN 1145  71        3.      57.      -54.
 23 JAN 2230  18      395.     629.    -234.  * 24 JAN 0515  45      226.     202.      24. * 24 JAN 1200  72        2.      55.      -53.
 23 JAN 2245  19      413.     797.    -384.  * 24 JAN 0530  46      178.     175.       3. * 24 JAN 1215  73        1.      55.      -54.
 23 JAN 2300  20      442.     912.    -470.  * 24 JAN 0545  47      133.     151.     -18. * 24 JAN 1230  74        1.      51.      -50.
 23 JAN 2315  21      487.     969.    -482.  * 24 JAN 0600  48       97.     136.     -39. * 24 JAN 1245  75        1.      51.      -50.
 23 JAN 2330  22      545.    1034.    -489.  * 24 JAN 0615  49       69.     116.     -47. * 24 JAN 1300  76        1.      51.      -50.
 23 JAN 2345  23      609.    1070.    -461.  * 24 JAN 0630  50       49.     116.     -67. * 24 JAN 1315  77        0.      49.      -49.
 24 JAN 0000  24      671.    1074.    -403.  * 24 JAN 0645  51       35.     108.     -73. * 24 JAN 1330  78        0.      49.      -49.
 24 JAN 0015  25      721.    1072.    -351.  * 24 JAN 0700  52       30.     101.     -71. * 24 JAN 1345  79        0.      46.      -46.
 24 JAN 0030  26      764.    1093.    -329.  * 24 JAN 0715  53       39.      99.     -60. * 24 JAN 1400  80        0.      40.      -40.
 24 JAN 0045  27      807.    1127.    -320.  * 24 JAN 0730  54       59.      99.     -40. *
                                              *                                            *
***************************************************************************************************************************
1                                                    STATION      051
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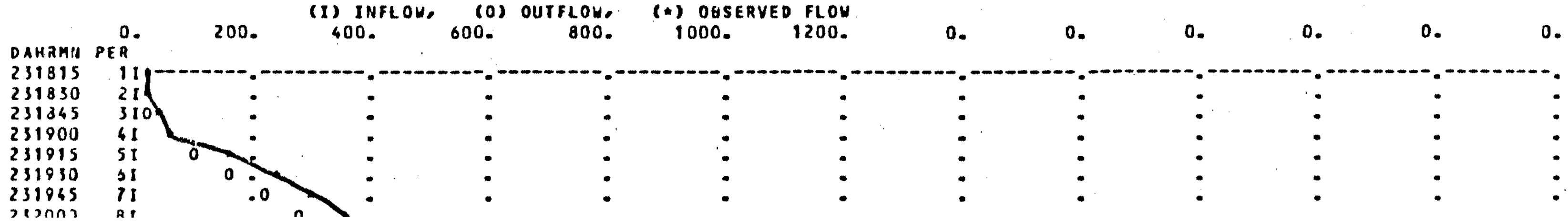
88



```
                                   (I) INFLOW,   (O) OUTFLOW,   (*) OBSERVED FLOW
            0.      200.      400.      600.      800.     1000.     1200.        0.        0.        0.        0.        0.        0.
DAHRMN PER
231815   1I---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
231830   2I         .         .         .         .         .         .         .         .         .         .         .         .
231845   3IO        .         .         .         .         .         .         .         .         .         .         .         .
231900   4I         .         .         .         .         .         .         .         .         .         .         .         .
231915   5I   O     .         .         .         .         .         .         .         .         .         .         .         .
231930   6I      O  .         .         .         .         .         .         .         .         .         .         .         .
231945   7I         .O        .         .         .         .         .         .         .         .         .         .         .
```

RUN 28 P1

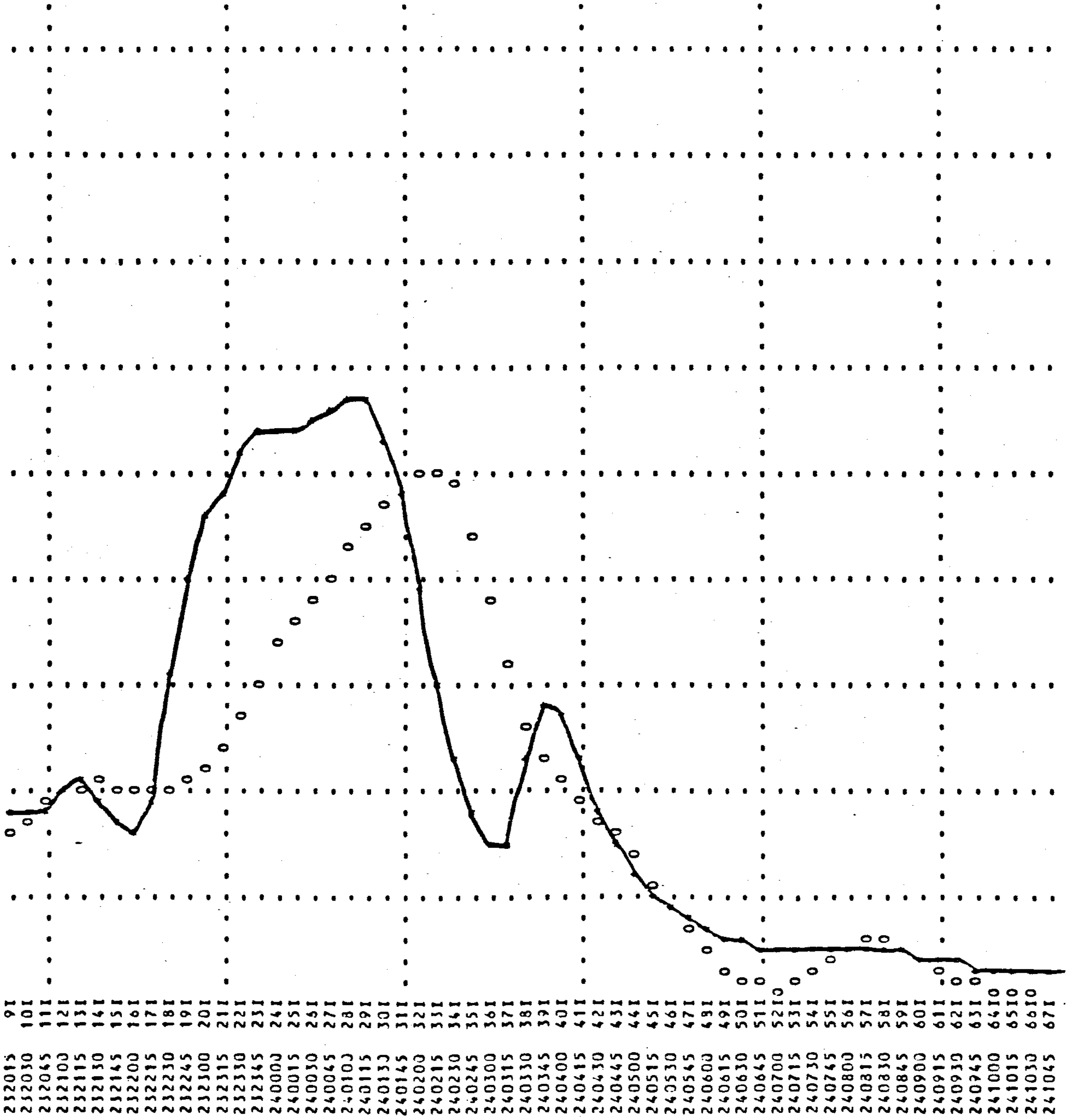
RUN28 P2

Storm 1. Data Enclosed. (Isohyetal rainfall)

	Sum of Flows	mean Flow	Time to Center of mass	peak Flow	time of peak
Computed	23592.	295	7.20	1007	8.00
observed	27370.	342	7.25	1149	6.75
Difference	-3778.	-47	-0.05	-142	1.25
% difference	-13.80 %			-12.33 %	

Standard error 193 Ave. Abs. error 118

objective Function 245 Ave. % Abs. error 44.22 %



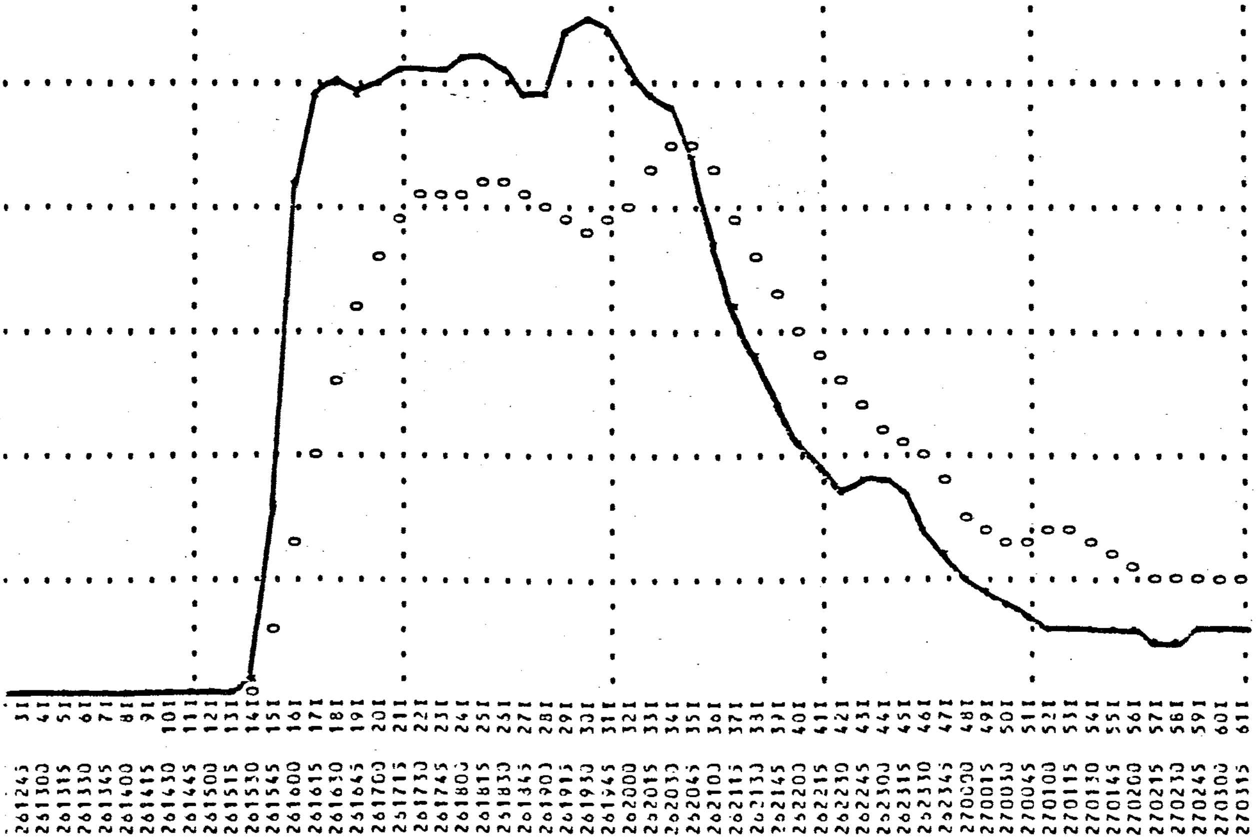
RUN 29 P1

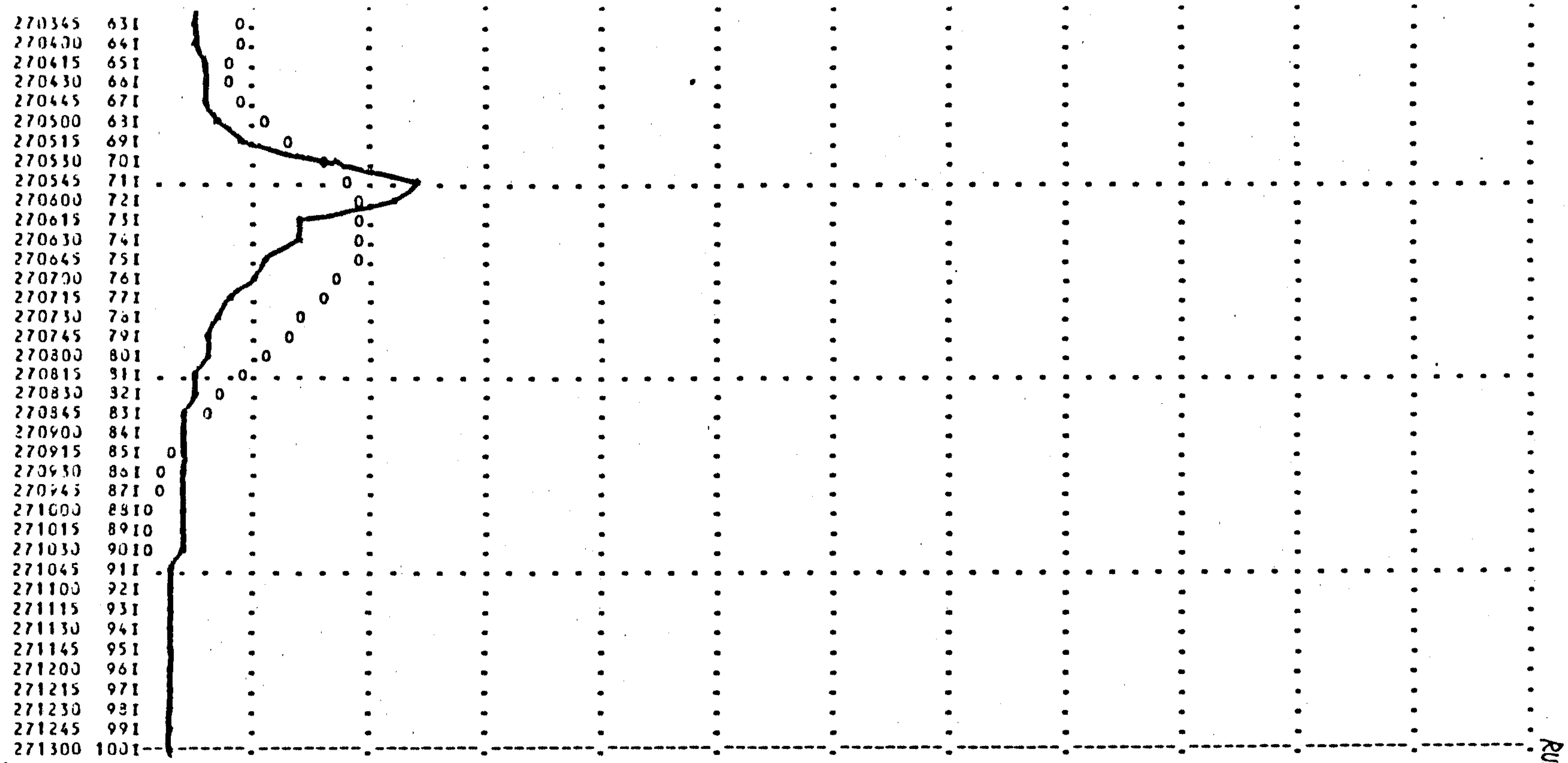
STORM 2. data enclosed. Isohyetal rainfall.

	Sum of flow	mean flow	time to C.M.	Peak Flow	Time of Peak
computed	31146	311	10.30	902	8.5
observed	32721	327	9.36	1099	7.25
difference	-1575		0.94	-197	1.25
% diff.	-4.81%	-16		-17.90%	

Standard error 157
objective function 203

Ave. Abs. Error 114
Ave. %. Abs. Error 54.43%





```
270345  63I            O.       .
270400  64I            O.       .
270415  65I           O .       .
270430  66I           O .       .
270445  67I            O.       .
270500  68I             .O      .
270515  69I             .   O   .
270530  70I             .       .
270545  71I. . . . . . . . . O  . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
270600  72I             .      O.
270615  73I             .      O.
270630  74I             .      O.
270645  75I             .      O.
270700  76I             .     O .
270715  77I             .    O  .
270730  78I             .   O   .
270745  79I             .  O    .
270800  80I             .O      .
270815  81I . . . . . .O. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
270830  82I         O   .       .
270845  83I        O    .       .
270900  84I             .       .
270915  85I  O          .       .
270930  86I O           .       .
270945  87I O           .       .
271000  88IO            .       .
271015  89IO            .       .
271030  90IO            .       .
271045  91I. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
271100  92I             .       .
271115  93I             .       .
271130  94I             .       .
271145  95I             .       .
271200  96I             .       .
271215  97I             .       .
271230  98I             .       .
271245  99I             .       .
271300 100I-------------.-------.---------.---------.---------.---------.---------.---------.---------.---------.
1
1
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91

RUN9P2.

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                                         RUNOFF SUMMARY
                                  FLOW IN CUBIC FEET PER SECOND
                               TIME IN HOURS,  AREA IN SQUARE MILES

                                       PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN    MAXIMUM    TIME OF
             OPERATION      STATION    FLOW     PEAK                                                AREA     STAGE    MAX STAGE
+                                                          6-HOUR      24-HOUR      72-HOUR

             HYDROGRAPH AT
+                               00A     447.     7.25        191.          58.          57.        2.98

             ROUTED TO
+                              1T02     370.     7.75        189.          58.          57.        2.98

             HYDROGRAPH AT
+                               00B     137.     3.50         77.          28.          27.        0.38

             HYDROGRAPH AT
+                               00B       2.     0.25          0.           0.           0.        0.70
```

92

```
 *    OBSERVED HYDROGRAPH        27370.      1.065           342.       7.25        7.25        1147.       6.75      *
 *                                                                                                                    *
 *    DIFFERENCE                 -3760.     -0.149           -47.      -0.02       -0.02        -134.       1.25      *
 *    PERCENT DIFFERENCE         -13.74                                            -0.30       -11.69                 *
 *                                                                                                                    *
 *                       STANDARD ERROR        199.                 AVERAGE ABSOLUTE ERROR      124.                  *
 *                   OBJECTIVE FUNCTION        253.         AVERAGE PERCENT ABSOLUTE ERROR      15.80                 *
 *                                                                                                                    *
**********************************************************************************************************************

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                                                 HYDROGRAPH AT STATION       051

**************************************************************************************************************************
                                             *                                                  *
 DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL * DA MON HRMN ORD   COMP Q    OBS Q  RESIDUL * DA MON HRMN ORD   COMP Q    OBS Q  RESIDUL
                                             *                                                  *
 23 JAN 1815   1      21.      22.      -1.  * 24 JAN 0100  28     838.    1149.    -311.  * 24 JAN 0745  55      74.     107.     -33.
 23 JAN 1830   2      21.      22.      -1.  * 24 JAN 0115  29     883.    1134.    -251.  * 24 JAN 0800  56     100.     107.      -7.
 23 JAN 1845   3      26.      37.      -4.  * 24 JAN 0130  30     926.    1067.    -141.  * 24 JAN 0815  57     119.     102.      17.
 23 JAN 1900   4      52.      57.      -5.  * 24 JAN 0145  31     967.     964.       3.  * 24 JAN 0830  58     123.      90.      33.
 23 JAN 1915   5      95.     150.     -55.  * 24 JAN 0200  32    1007.     777.     230.  * 24 JAN 0845  59     111.      90.      21.
 23 JAN 1930   6     192.     231.     -32.  * 24 JAN 0215  33    1015.     608.     407.  * 24 JAN 0900  60      81.      80.       1.
 23 JAN 1945   7     214.     299.     -85.  * 24 JAN 0230  34     981.     469.     512.  * 24 JAN 0915  61      64.      81.     -17.
 23 JAN 2000   8     272.     355.     -83.  * 24 JAN 0245  35     891.     365.     526.  * 24 JAN 0930  62      56.      77.     -21.
 23 JAN 2015   9     318.     359.     -41.  * 24 JAN 0300  36     767.     361.     406.  * 24 JAN 0945  63      36.      67.     -31.
 23 JAN 2030  10     356.     352.       4.  * 24 JAN 0315  37     644.     301.     343.  * 24 JAN 1000  64      25.      67.     -42.
 23 JAN 2045  11     384.     369.      15.  * 24 JAN 0330  38     545.     460.      85.  * 24 JAN 1015  65      17.      67.     -50.
 23 JAN 2100  12     403.     405.      -2.  * 24 JAN 0345  39     479.     567.     -88.  * 24 JAN 1030  66      12.      65.     -53.
 23 JAN 2115  13     414.     414.       0.  * 24 JAN 0400  40     440.     538.     -98.  * 24 JAN 1045  67       8.      61.     -53.
 23 JAN 2130  14     418.     384.      34.  * 24 JAN 0415  41     417.     458.     -41.  * 24 JAN 1100  68       6.      59.     -53.
 23 JAN 2145  15     416.     331.      85.  * 24 JAN 0430  42     383.     375.      16.  * 24 JAN 1115  69       4.      57.     -53.
 23 JAN 2200  16     407.     312.      95.  * 24 JAN 0445  43     343.     299.      44.  * 24 JAN 1130  70       3.      57.     -54.
 23 JAN 2215  17     394.     388.       6.  * 24 JAN 0500  44     292.     245.      47.  * 24 JAN 1145  71       2.      57.     -55.
 23 JAN 2230  18     392.     629.    -237.  * 24 JAN 0515  45     233.     202.      31.  * 24 JAN 1200  72       1.      55.     -54.
 23 JAN 2245  19     404.     797.    -393.  * 24 JAN 0530  46     177.     175.       2.  * 24 JAN 1215  73       1.      55.     -54.
 23 JAN 2300  20     429.     912.    -483.  * 24 JAN 0545  47     129.     151.     -22.  * 24 JAN 1230  74       1.      51.     -50.
 23 JAN 2315  21     459.     959.    -500.  * 24 JAN 0600  48      91.     136.     -45.  * 24 JAN 1245  75       1.      51.     -50.
 23 JAN 2330  22     520.    1034.    -514.  * 24 JAN 0615  49      63.     116.     -53.  * 24 JAN 1300  76       0.      51.     -51.
 23 JAN 2345  23     535.    1074.    -465.  * 24 JAN 0630  50      44.     116.     -72.  * 24 JAN 1315  77       0.      47.     -47.
 24 JAN 0000  24     652.    1074.    -422.  * 24 JAN 0645  51      30.     108.     -78.  * 24 JAN 1330  78       0.      49.     -49.
 24 JAN 0015  25     707.    1072.    -365.  * 24 JAN 0700  52      25.     101.     -76.  * 24 JAN 1345  79       0.      45.     -45.
 24 JAN 0030  26     757.    1093.    -336.  * 24 JAN 0715  53      33.      99.     -66.  * 24 JAN 1400  80       0.      41.     -41.
 24 JAN 0045  27     795.    1127.    -332.  * 24 JAN 0730  54      50.      99.     -49.  *
                                             *                                                  *
**************************************************************************************************************************
1                                                        STATION       051
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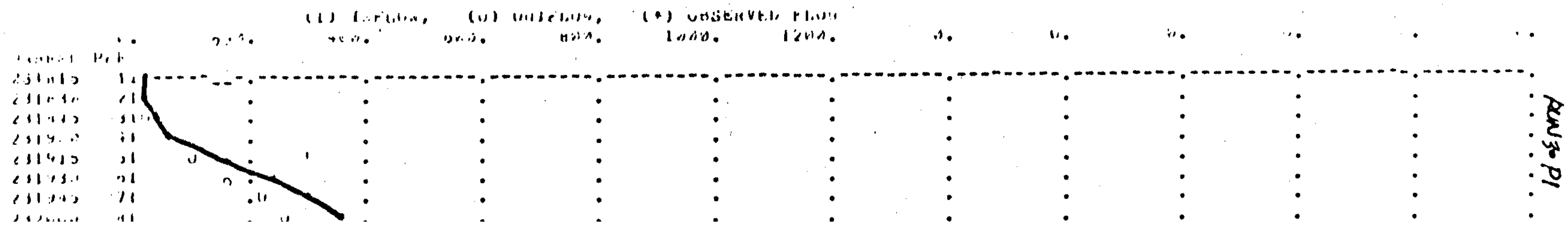


RUN3-P1

RUN 30 P2

STORM 1 ADJUST NSTPS .(RS) OF SUBAREAS BACK TO REASONABLE RANGE
RSVRIC .(RS) OF SUBAREAS. (STARTING VALUE). = STRTQ (BF)

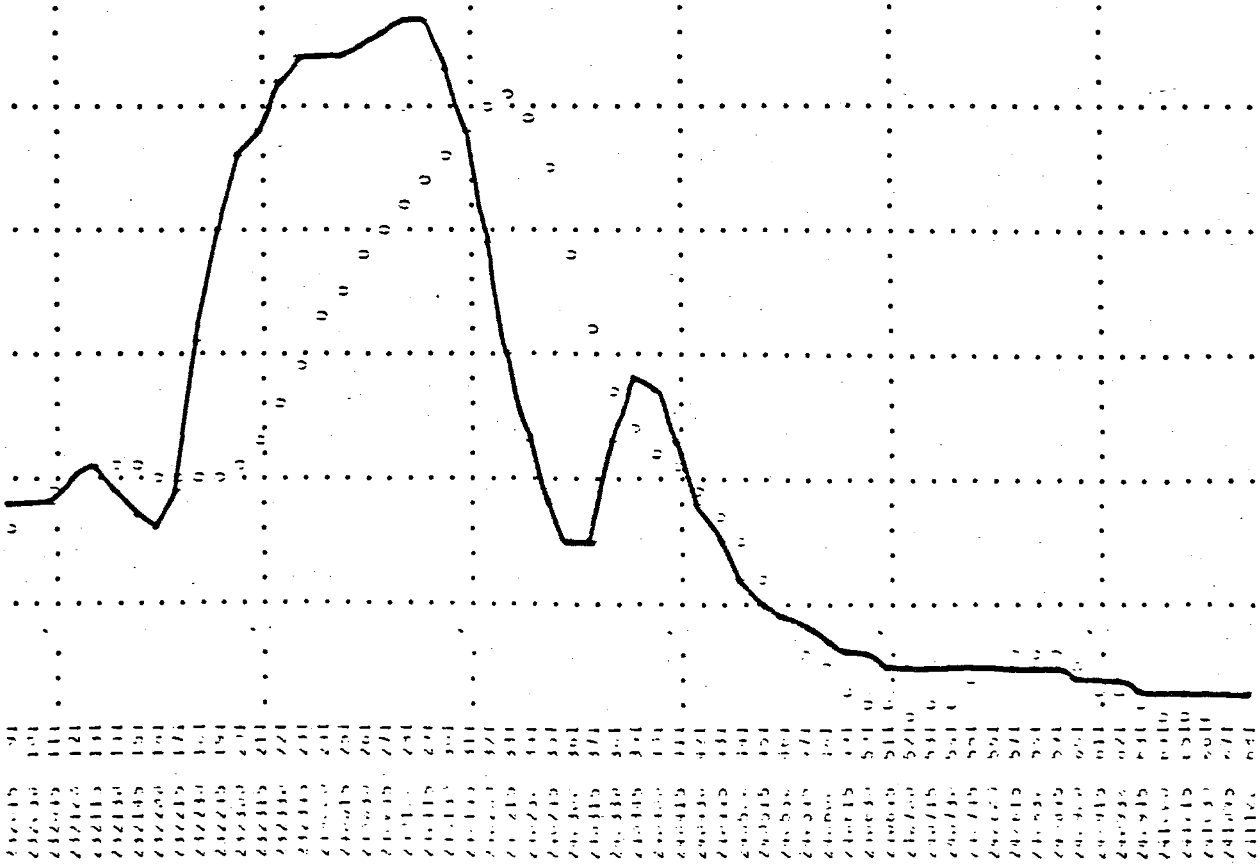
	SUM OF FLOWS	MEAN FLOW	TIME TO C.M:	PEAK FLOW	TIME OF PEAK
Computed	23610	.295	7.22	1015	8.00
observed	27370	.342	7.25	1149	6.75
Diff.	-3760	-47	-0.02	-134	1.25
Diff %	-13.74%			-11.64%	

STANDARD ERROR = .199

AVE. % ABS. ERROR = 45.86%

Ave. Abs. Error = 123

CHANGES:	NSTPS (RS)	RSVRIC (RS)
B :	2	3
H :	2	4
J :	1	1
I :	3	2
M :	2	2
L :	1	1
N :	1	2



RUN,AP1

STORM2

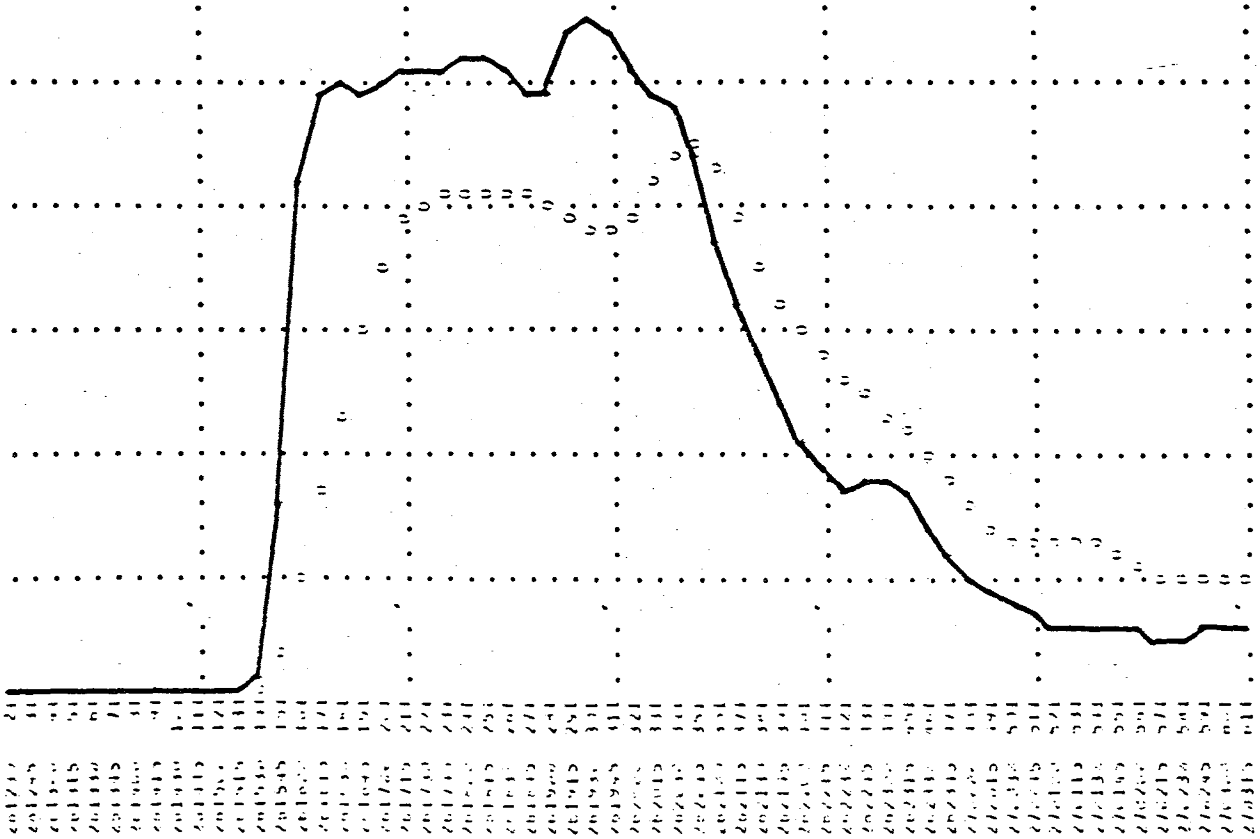
SAME DATA AS STORM1 BEFORE.

	SUM OF FLOWS	MEAN FLOW	Time to C.M.	Peak Flow	Time of Peak
Computed	31138	311	10.50	894	8.50
Observed	32721	327	9.36	1099	7.25
Diff.	-1583	-16	1.14	-205	1.25
Diff %	-4.84		12.18%	-18.67%	

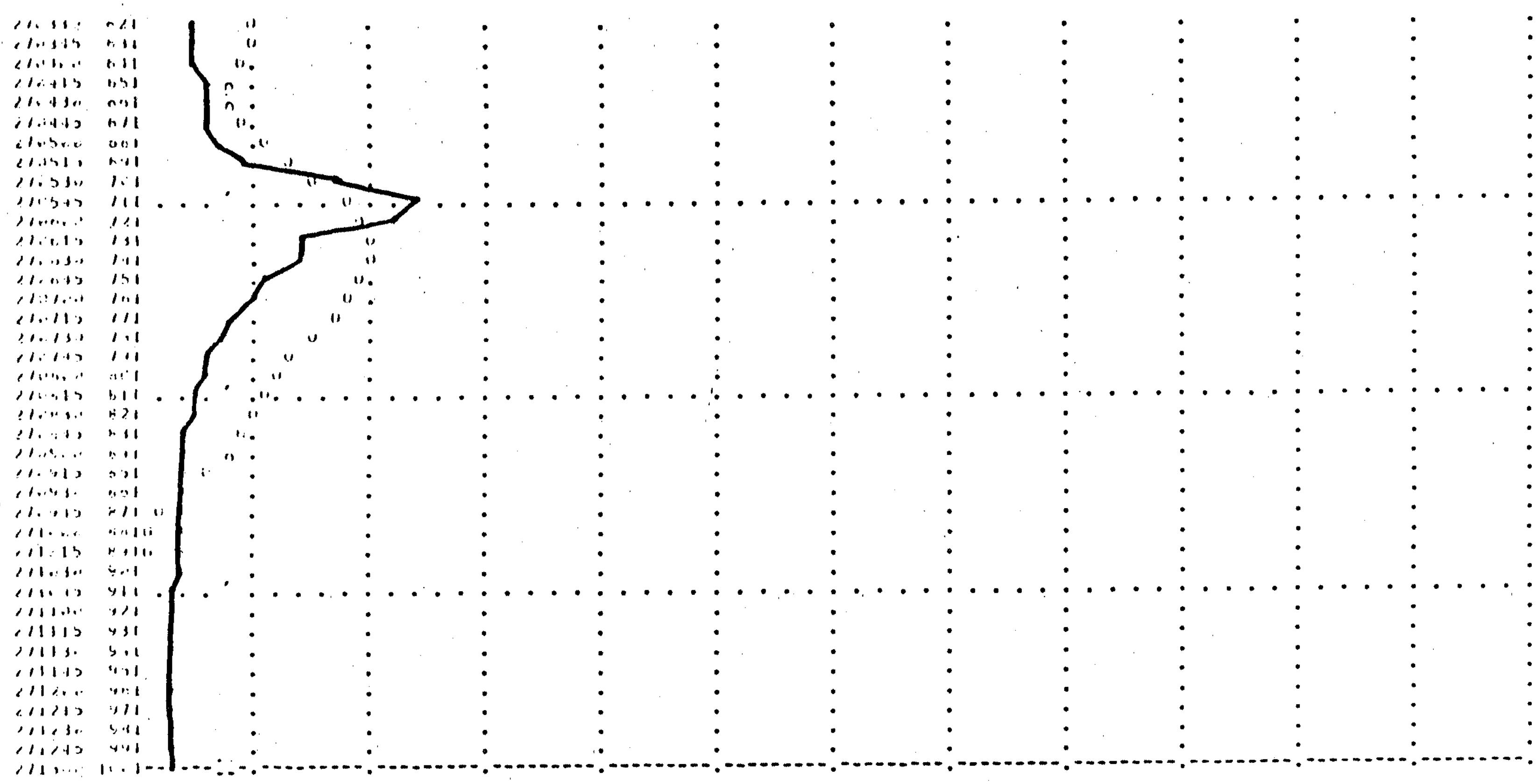
STANDARD ERROR = 168

AVE. % ABS. ERROR = 58.02%

AVE. ABS. ERROR = 121



RUN31 P2



RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	20A	447.	7.25	191.	58.	57.	2.98		
ROUTED TO	1102	376.	7.75	189.	58.	57.	2.98		
HYDROGRAPH AT	66B	137.	3.50	77.	28.	27.	0.38		
HYDROGRAPH AT									

96

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*     OBSERVED HYDROGRAPH          27370.      1.065          342.       7.25       7.25       1149.      0.75     *
*                                                                                                               *
*     DIFFERENCE                    -840.     -0.033          -11.       0.07       0.07         95.      1.25     *
*     PERCENT DIFFERENCE           -3.07                                            1.03        8.26              *
*                                                                                                               *
*                    STANDARD ERROR       224.                AVERAGE ABSOLUTE ERROR       132.                    *
*                 OBJECTIVE FUNCTION      267.         AVERAGE PERCENT ABSOLUTE ERROR     49.57                    *
*                                                                                                               *
*****************************************************************************************************************

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                                         HYDROGRAPH AT STATION       051

**********************************************************************************************************************
                                           *                                                  *
 DA MON HRMN ORD    COMP Q    OBS Q   RESIDUAL * DA MON HRMN ORD    COMP Q    OBS Q   RESIDUAL * DA MON HRMN ORD    COMP Q    OBS Q   RESIDUAL
                                           *                                                  *
 23 JAN 1815   1      21.      22.      -1. * 24 JAN 0100  28      974.    1149.    -175. * 24 JAN 0745  55      71.     107.     -36.
 23 JAN 1830   2      21.      22.      -1. * 24 JAN 0115  29     1040.    1134.     -94. * 24 JAN 0800  56      96.     107.     -11.
 23 JAN 1845   3      28.      32.      -4. * 24 JAN 0130  30     1102.    1067.      35. * 24 JAN 0815  57     113.     102.      11.
 23 JAN 1900   4      52.      57.      -5. * 24 JAN 0145  31     1162.     964.     198. * 24 JAN 0830  58     116.      96.      20.
 23 JAN 1915   5      95.     150.     -55. * 24 JAN 0200  32     1218.     772.     446. * 24 JAN 0845  59     105.      92.      13.
 23 JAN 1930   6     153.     214.     -61. * 24 JAN 0215  33     1244.     608.     636. * 24 JAN 0900  60      53.      51.       2.
 23 JAN 1945   7     234.     299.     -65. * 24 JAN 0230  34     1207.     469.     738. * 24 JAN 0915  61      62.      76.     -14.
 23 JAN 2000   8     269.     355.     -86. * 24 JAN 0245  35     1098.     365.     733. * 24 JAN 0930  62      44.      77.     -33.
 23 JAN 2015   9     317.     359.     -42. * 24 JAN 0300  36      944.     301.     643. * 24 JAN 0945  63      31.      67.     -36.
 23 JAN 2030  10     356.     352.       4. * 24 JAN 0315  37      788.     301.     487. * 24 JAN 1000  64      21.      67.     -46.
 23 JAN 2045  11     365.     349.      16. * 24 JAN 0330  38      661.     460.     201. * 24 JAN 1015  65      11.      67.     -56.
 23 JAN 2100  12     464.     465.      -1. * 24 JAN 0345  39      571.     567.       4. * 24 JAN 1030  66       6.      63.     -57.
 23 JAN 2115  13     416.     414.       2. * 24 JAN 0400  40      516.     538.     -22. * 24 JAN 1045  67       6.      61.     -55.
 23 JAN 2130  14     420.     384.      36. * 24 JAN 0415  41      482.     458.      24. * 24 JAN 1100  68       4.      57.     -53.
 23 JAN 2145  15     418.     331.      87. * 24 JAN 0430  42      454.     365.      89. * 24 JAN 1115  69       3.      57.     -54.
 23 JAN 2200  16     408.     312.      96. * 24 JAN 0445  43      409.     299.     110. * 24 JAN 1130  70       2.      59.     -57.
 23 JAN 2215  17     397.     388.       9. * 24 JAN 0500  44      350.     245.     105. * 24 JAN 1145  71       1.      57.     -56.
 23 JAN 2230  18     395.     629.    -234. * 24 JAN 0515  45      275.     202.      73. * 24 JAN 1200  72       1.      55.     -54.
 23 JAN 2245  19     408.     777.    -369. * 24 JAN 0530  46      202.     175.      27. * 24 JAN 1215  73       0.      53.     -53.
 23 JAN 2300  20     438.     912.    -474. * 24 JAN 0545  47      142.     151.      -9. * 24 JAN 1230  74       0.      51.     -51.
 23 JAN 2315  21     477.     959.    -482. * 24 JAN 0600  48       97.     136.     -39. * 24 JAN 1245  75       0.      51.     -51.
 23 JAN 2330  22     551.    1134.    -583. * 24 JAN 0615  49       66.     116.     -50. * 24 JAN 1300  76       0.      51.     -51.
 23 JAN 2345  23     635.    1470.    -835. * 24 JAN 0630  50       44.     116.     -72. * 24 JAN 1315  77       0.      47.     -47.
 24 JAN 0000  24     722.    1074.    -352. * 24 JAN 0645  51       30.     108.     -78. * 24 JAN 1330  78       0.      43.     -43.
 24 JAN 0015  25     793.    1072.    -279. * 24 JAN 0700  52       25.     101.     -76. * 24 JAN 1345  79       0.      40.     -40.
 24 JAN 0030  26     851.    1063.    -212. * 24 JAN 0715  53       32.      99.     -67. * 24 JAN 1400  80       0.      42.     -42.
 24 JAN 0045  27     910.    1127.    -217. * 24 JAN 0730  54       48.      99.     -51. *
                                           *                                                  *
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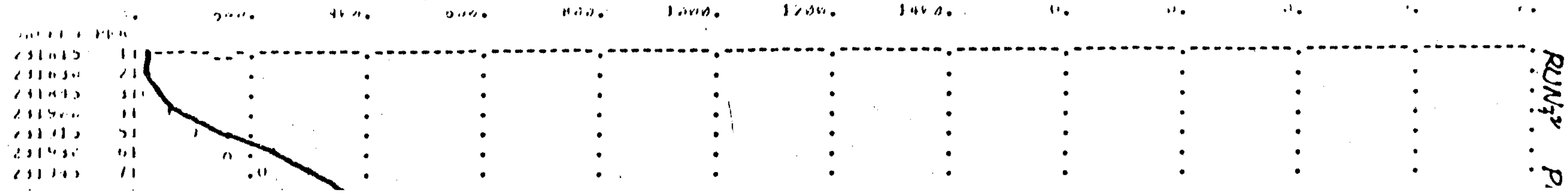
                                                      STATION       051

                              (I) INFLOW,    (O) OUTFLOW,    (*) OBSERVED FLOW
```



RUN7 P.

RUN 3rd P2

STORM 1

FINAL DATA BEFORE RECONSTRUCTION.

	SUM OF FLOWS	MEAN FLOW	TIME TO C.M.	PEAK FLOW	TIME OF PEAK
COMPUTED	26530	332	7.32	1244	8.00
OBSERVED	27370	342	7.25	1149	6.75
DIFF.	−840	−11	0.07	95	1.25
DIFF. %	−3.07%			8.28%	

STANDARD ERROR = 224

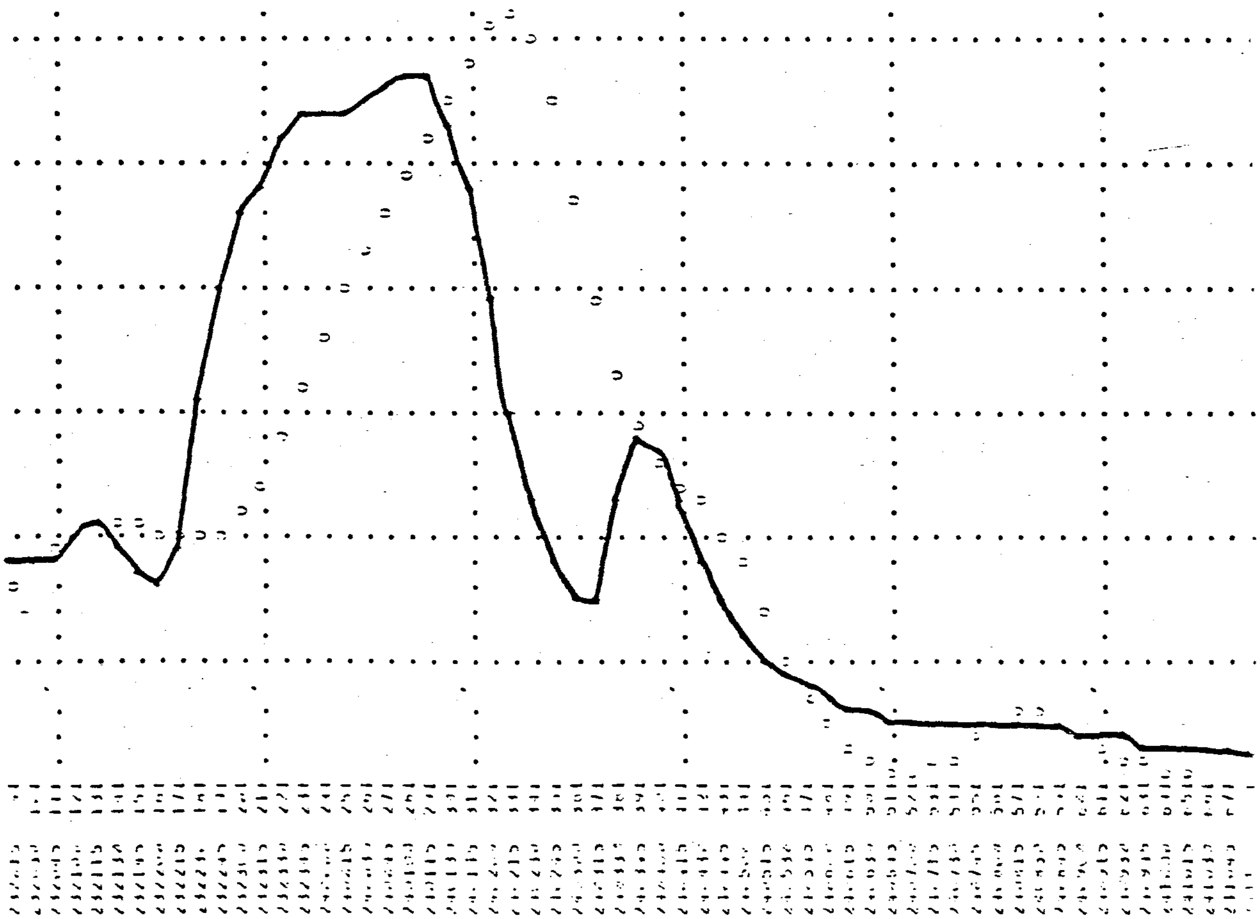
AVE. % ABS. ERROR = 49.97%

AVE. ABS. ERROR = 132

MAJOR CHANGES.

SUBAREA	STRKR (LE)	DLTKR (LE)	RTIOR (BF)
A :	0.6	1.3	5.5
B_p :	0.7	1.36	3.5
Hp :	0.7	1.51	3.5
Jp :	0.4	0.75	3.5
Ip :	0.5	0.96	3.5
Mp :	0.5	0.95	3.5
Lp :	0.4	0.8	3.5
Np :	0.5	0.92	3.6

AND B_I, H_I, J_I, I_I, M_I, L_I, N_I, RTIOR ALL CHANGED TO 6.5



STORM 2

Same data for parameters as RUN 33 P1

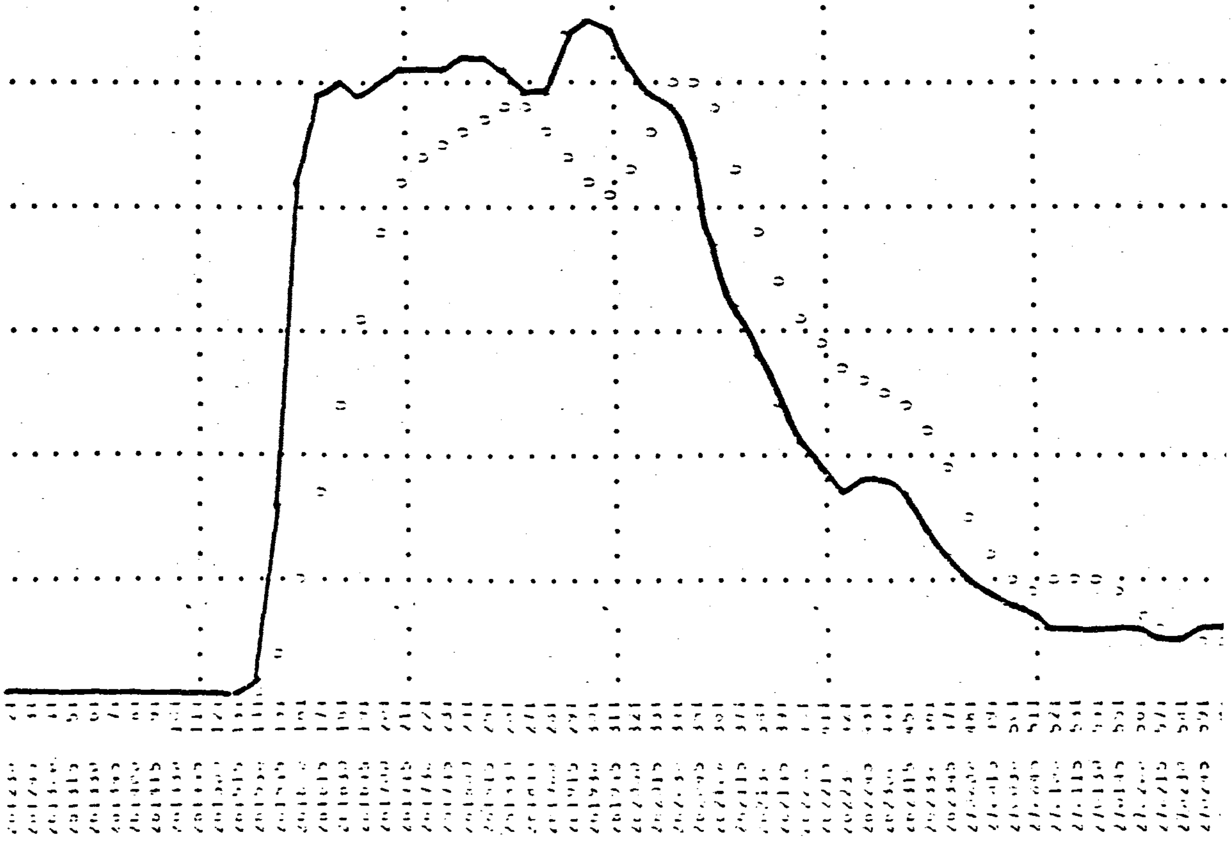
FINAL DATA BEFORE RECONSTITUTION.

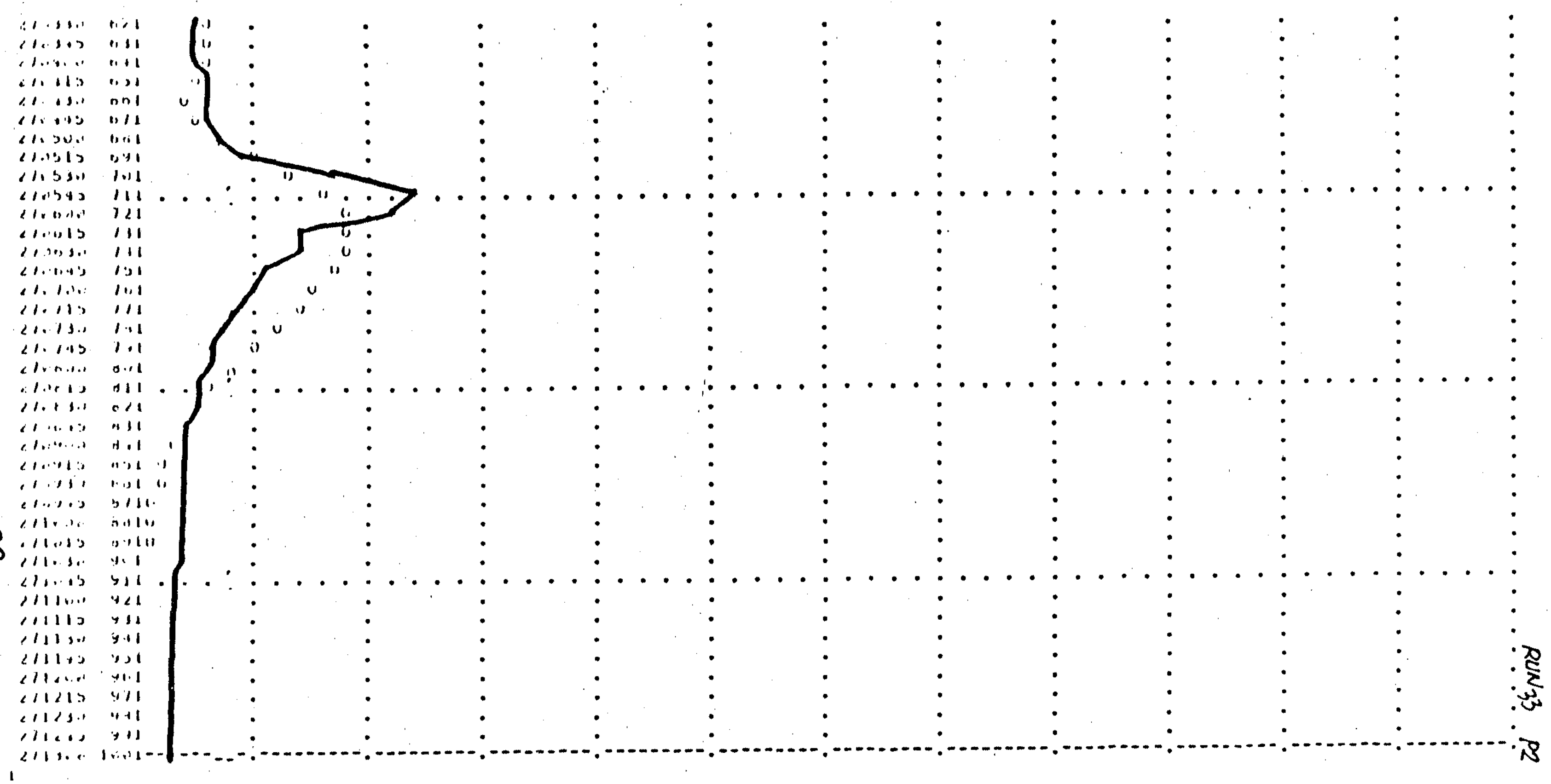
	Sum of Flows	mean Flow	Time To C.M.	Peak Flow	Time to peak
Computed	30701	307	9.76	1007	8.50
Observed	32721	327	9.36	1099	7.25
Diff.	-2020	-20	0.41	-92	1.25
% Diff	-6.17%			-8.41%	

Standard Error = 150

Ave % ABS. Er = 42.45%

Ave Abs. Error = 95





RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	[illegible]	597.	7.25	269.	76.	76.	2.96		
ROUTED TO	1102	497.	7.75	267.	76.	76.	2.96		
HYDROGRAPH AT	40B	137.	3.50	77.	26.	27.	0.36		

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*   OBSERVED  HYDROGRAPH        27370.     1.065          392.      7.25       7.25       1149.       1.00     *
*                                                                                                              *
*   DIFFERENCE                  -1896.    -0.075          -24.      0.17       0.17         10.       1.25     *
*   PERCENT   DIFFERENCE        -6.93                                          2.35        0.87                *
*                                                                                                              *
*                    STANDARD ERROR        231.             AVERAGE ABSOLUTE ERROR        135.                 *
*                  OBJECTIVE FUNCTION      283.     AVERAGE PERCENT ABSOLUTE ERROR        52.08                *
*                                                                                                              *
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                                     HYDROGRAPH AT STATION      051

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                                             *                                               *
 DA MON HRMN ORD      COMP Q   OBS Q  RESIDUAL * DA MON HRMN ORD   COMP Q   OBS Q  RESIDUAL * DA MON HRMN ORD   COMP Q   OBS Q  RESIDUAL
                                             *                                               *
 23 JAN 1815   1        21.      22.      -1. * 24 JAN 0100  28      882.   1149.    -267. * 24 JAN 0745  55      58.     107.     -49.
 23 JAN 1830   2        21.      22.      -1. * 24 JAN 0115  29      942.   1134.    -192. * 24 JAN 0800  56      74.     107.     -33.
 23 JAN 1845   3        26.      32.      -6. * 24 JAN 0130  30     1004.   1067.     -63. * 24 JAN 0815  57      92.     102.     -10.
 23 JAN 1900   4        45.      57.     -12. * 24 JAN 0145  31     1066.    964.     102. * 24 JAN 0830  58      89.      90.      -1.
 23 JAN 1915   5        78.     150.     -72. * 24 JAN 0200  32     1122.    772.     350. * 24 JAN 0845  59      81.      90.      -9.
 23 JAN 1930   6       125.     234.    -109. * 24 JAN 0215  33     1159.    608.     551. * 24 JAN 0900  60      66.      81.     -15.
 23 JAN 1945   7       176.     299.    -123. * 24 JAN 0230  34     1157.    469.     688. * 24 JAN 0915  61      55.      81.     -26.
 23 JAN 2000   8       225.     355.    -130. * 24 JAN 0245  35     1103.    365.     738. * 24 JAN 0930  62      41.      77.     -36.
 23 JAN 2015   9       270.     359.     -89. * 24 JAN 0300  36     1002.    301.     701. * 24 JAN 0945  63      26.      67.     -41.
 23 JAN 2030  10       311.     352.     -41. * 24 JAN 0315  37      878.    301.     577. * 24 JAN 1000  64      20.      57.     -37.
 23 JAN 2045  11       344.     369.     -25. * 24 JAN 0330  38      756.    460.     296. * 24 JAN 1015  65      14.      67.     -53.
 23 JAN 2100  12       370.     405.     -35. * 24 JAN 0345  39      660.    567.      93. * 24 JAN 1030  66      10.      65.     -55.
 23 JAN 2115  13       389.     414.     -25. * 24 JAN 0400  40      588.    538.      50. * 24 JAN 1045  67       7.      61.     -54.
 23 JAN 2130  14       397.     381.      16. * 24 JAN 0415  41      535.    458.      77. * 24 JAN 1100  68       5.      59.     -54.
 23 JAN 2145  15       403.     331.      72. * 24 JAN 0430  42      479.    365.     114. * 24 JAN 1115  69       3.      59.     -56.
 23 JAN 2200  16       379.     312.      67. * 24 JAN 0445  43      417.    299.     118. * 24 JAN 1130  70       2.      59.     -57.
 23 JAN 2215  17       391.     388.       3. * 24 JAN 0500  44      343.    245.      98. * 24 JAN 1145  71       2.      57.     -55.
 23 JAN 2230  18       393.     629.    -236. * 24 JAN 0515  45      268.    202.      66. * 24 JAN 1200  72       1.      55.     -54.
 23 JAN 2245  19       404.     797.    -393. * 24 JAN 0530  46      201.    175.      26. * 24 JAN 1215  73       1.      55.     -54.
 23 JAN 2300  20       423.     912.    -489. * 24 JAN 0545  47      147.    151.      -4. * 24 JAN 1230  74       1.      51.     -50.
 23 JAN 2315  21       468.     969.    -501. * 24 JAN 0600  48      100.    130.     -30. * 24 JAN 1245  75       0.      51.     -51.
 23 JAN 2330  22       517.    1034.    -517. * 24 JAN 0615  49       75.    116.     -41. * 24 JAN 1300  76       0.      51.     -51.
 23 JAN 2345  23       579.    1070.    -491. * 24 JAN 0630  50       53.    116.     -63. * 24 JAN 1315  77       0.      49.     -49.
 24 JAN 0000  24       649.    1074.    -425. * 24 JAN 0645  51       37.    108.     -71. * 24 JAN 1330  78       0.      49.     -49.
 24 JAN 0015  25       715.    1072.    -357. * 24 JAN 0700  52       29.    101.     -72. * 24 JAN 1345  79       0.      46.     -46.
 24 JAN 0030  26       772.    1093.    -321. * 24 JAN 0715  53       32.     99.     -67. * 24 JAN 1400  80       0.      46.     -46.
 24 JAN 0045  27       826.    1127.    -301. * 24 JAN 0730  54       43.     99.     -56. *
                                             *
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                                               STATION      051
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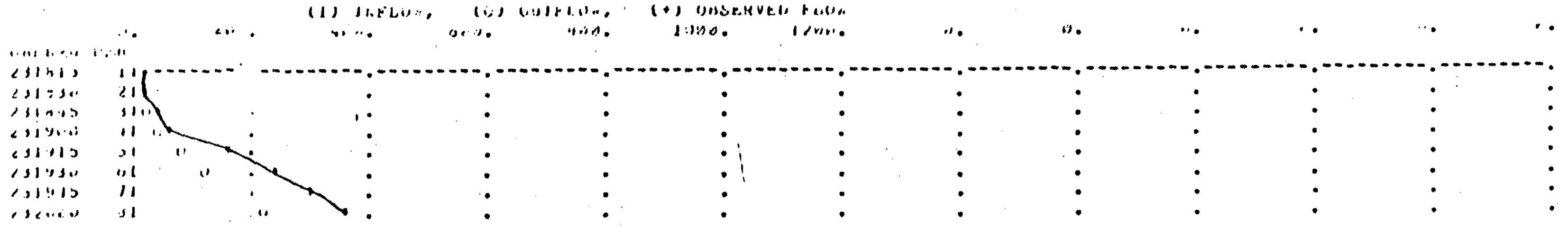


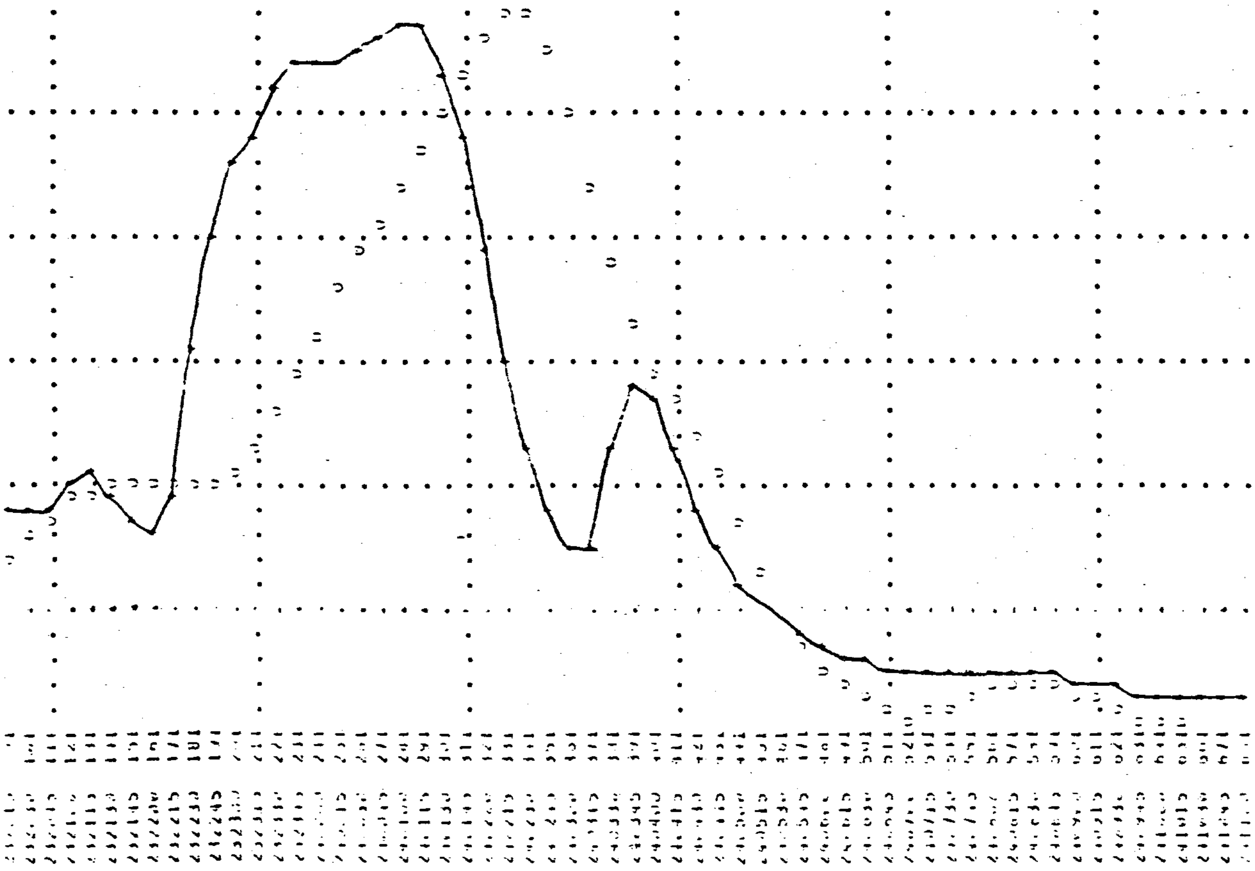
100

RUN # P1

RUN 34 P2

STORM 1 USE Tc and R from hydrographic Analysis

	Sum of Flows	mean flow	Time to C.M	Peak flow	Time to Peak
Computed	25474	318	7.42	1159	8.00
observed	27370	342	7.25	1149	6.75
Diff.	- 1896	-24	0.17	10	1.25
Diff %	-6.93 %			0.88%	
STANDARD ERROR	234				
Ave Abs. Error	144				
Ave. % Abs. Error	52.68%				



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*     OBSERVED HYDROGRAPH        27370.      1.035          342.      7.25       7.25       1149.      6.75     *
*                                                                                                               *
*     DIFFERENCE                  3585.      0.142           45.      0.56       0.56         29.      1.50     *
*     PERCENT DIFFERENCE          13.10                                          7.79         2.55              *
*                                                                                                               *
*                  STANDARD ERROR        259.              AVERAGE ABSOLUTE ERROR       175.                     *
*              OBJECTIVE FUNCTION        294.      AVERAGE PERCENT ABSOLUTE ERROR     67.95                      *
*                                                                                                               *
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                                          HYDROGRAPH AT STATION      051

***********************************************************************************************************************
                                           *                                              *
 DA MON HRMN ORD   COMP Q    OBS Q  RESIDUL * DA MON HRMN ORD   COMP Q   OBS Q  RESIDUL * DA MON HRMN ORD   COMP Q   OBS Q  RESIDUL
                                           *                                              *
 23 JAN 1815   1      71.      72.      -1. * 24 JAN 0100  28     894.   1149.    -255. * 24 JAN 0745  55     123.    107.      16.
 23 JAN 1830   2      71.      72.      -1. * 24 JAN 0115  29     933.   1134.    -201. * 24 JAN 0800  56     146.    107.      39.
 23 JAN 1845   3      51.      52.      -1. * 24 JAN 0130  30     982.   1067.     -85. * 24 JAN 0815  57     159.    102.      57.
 23 JAN 1900   4      61.      57.       4. * 24 JAN 0145  31    1047.    964.      83. * 24 JAN 0830  58     155.     90.      65.
 23 JAN 1915   5  [illegible] [illegible] [illegible] * 24 JAN 0200  32    1121.    772.     349. * 24 JAN 0845  59     134.     90.      44.
 23 JAN 1930   6     177.     234.     -57. * 24 JAN 0215  33    1175.    608.     567. * 24 JAN 0900  60     105.     81.      24.
 23 JAN 1945   7     244.     299.     -55. * 24 JAN 0230  34    1178.    469.     709. * 24 JAN 0915  61      78.     81.      -3.
 23 JAN 2000   8     303.     355.     -52. * 24 JAN 0245  35    1123.    365.     758. * 24 JAN 0930  62      55.     77.     -22.
 23 JAN 2015   9     354.     359.      -5. * 24 JAN 0300  36    1035.    301.     734. * 24 JAN 0945  63      38.     67.     -29.
 23 JAN 2030  10     395.     352.      43. * 24 JAN 0315  37     943.    301.     642. * 24 JAN 1000  64      26.     67.     -41.
 23 JAN 2045  11     414.     359.      55. * 24 JAN 0330  38     861.    460.     401. * 24 JAN 1015  65      17.     67.     -50.
 23 JAN 2100  12     445.     405.      40. * 24 JAN 0345  39     793.    567.     226. * 24 JAN 1030  66      12.     65.     -53.
 23 JAN 2115  13     458.     414.      44. * 24 JAN 0400  40     741.    538.     203. * 24 JAN 1045  67       8.     61.     -53.
 23 JAN 2130  14  [illegible] [illegible]  [illegible] * 24 JAN 0415  41     707.    458.     249. * 24 JAN 1100  68       5.     59.     -54.
 23 JAN 2145  15     478.     331.     147. * 24 JAN 0430  42     689.    365.     324. * 24 JAN 1115  69       3.     59.     -56.
 23 JAN 2200  16     474.     312.     162. * 24 JAN 0445  43     673.    299.     374. * 24 JAN 1130  70       2.     59.     -57.
 23 JAN 2215  17  [illegible] [illegible]      67. * 24 JAN 0500  44     658.    245.     413. * 24 JAN 1145  71       1.     57.     -56.
 23 JAN 2230  18     437.     629.    -192. * 24 JAN 0515  45     627.    202.     425. * 24 JAN 1200  72       1.     55.     -54.
 23 JAN 2245  19     437.     797.    -360. * 24 JAN 0530  46     568.    175.     393. * 24 JAN 1215  73       1.     55.     -54.
 23 JAN 2300  20     463.     912.    -449. * 24 JAN 0545  47     481.    151.     330. * 24 JAN 1230  74       0.     51.     -51.
 23 JAN 2315  21     512.     969.    -457. * 24 JAN 0600  48     395.    136.     259. * 24 JAN 1245  75       0.     51.     -51.
 23 JAN 2330  22     575.    1034.    -459. * 24 JAN 0615  49     325.    116.     209. * 24 JAN 1300  76       0.     51.     -51.
 23 JAN 2345  23     646.    1070.    -424. * 24 JAN 0630  50     257.    116.     141. * 24 JAN 1315  77       0.     49.     -49.
 24 JAN 0000  24     714.    1074.    -360. * 24 JAN 0645  51     187.    108.      79. * 24 JAN 1330  78       0.     49.     -49.
 24 JAN 0015  25     770.    1072.    -302. * 24 JAN 0700  52     130.    101.      29. * 24 JAN 1345  79       0.     46.     -46.
 24 JAN 0030  26     817.    1093.    -276. * 24 JAN 0715  53     104.     99.       5. * 24 JAN 1400  80       0.     40.     -40.
 24 JAN 0045  27     857.    1127.    -270. * 24 JAN 0730  54     105.     99.       6. *
                                           *                                              *
***********************************************************************************************************************
1                                                  STATION      051
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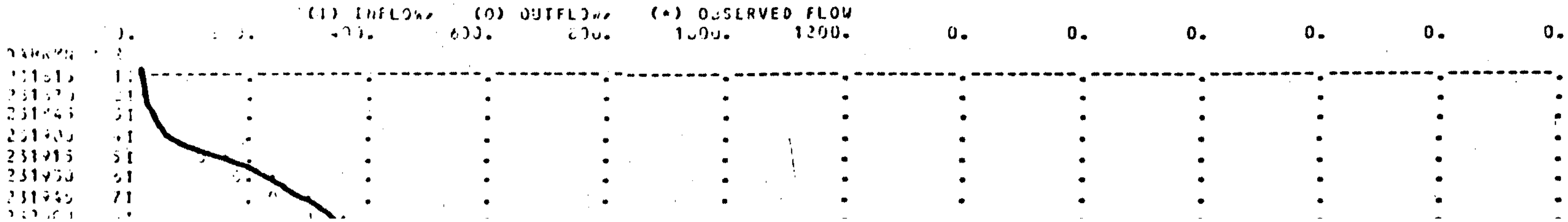
102



Run 3e-1

RUN 34-1 PZ

STORM #1 (THEISSEN).

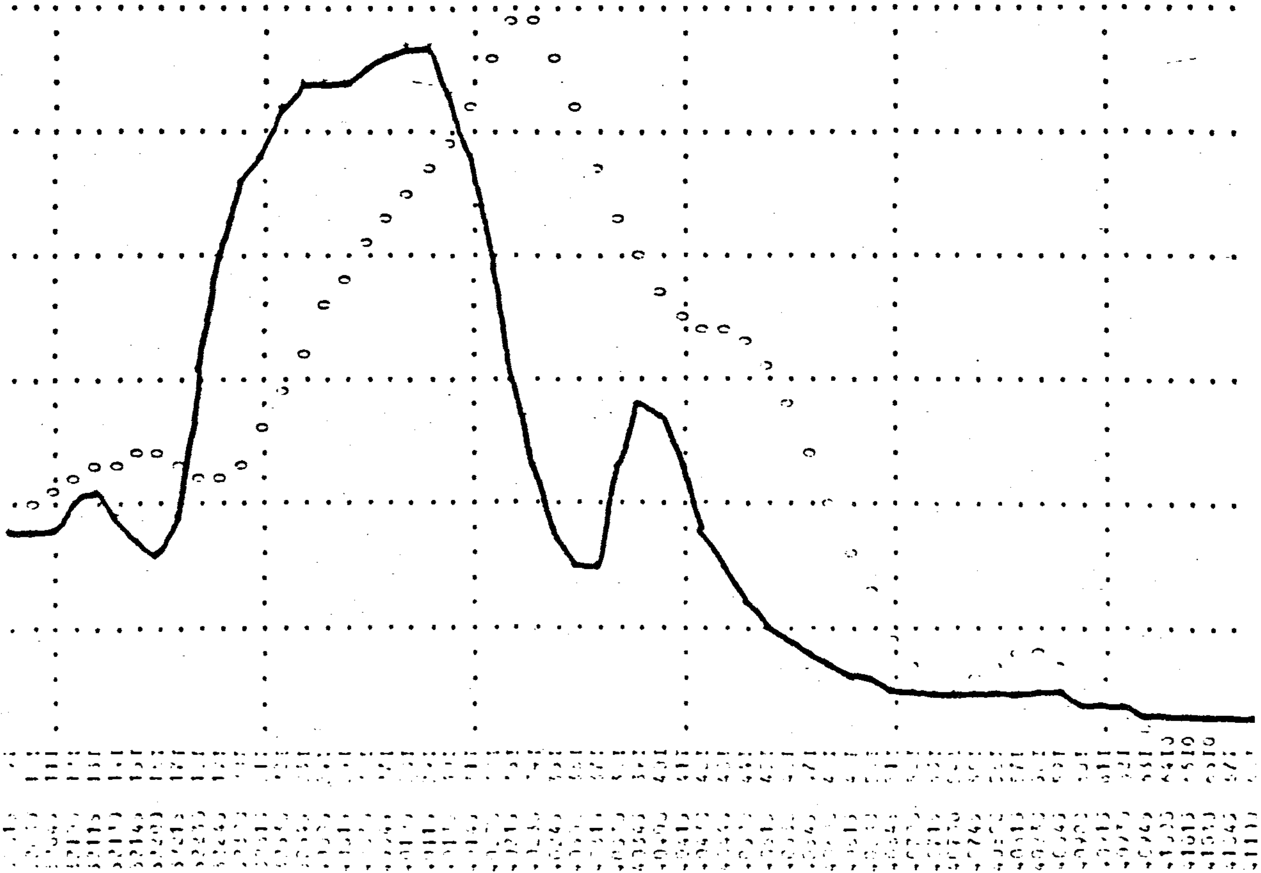
* Refer to storm #1 on RUN 34, which is Isohyetal Rainfall distribution. Same data as RUN 34.

	sum of flow	mean flow	Time to C.M.	peak flow	Time to peak
Computed	30955	387	7.81	1178	8.25
Observed	27370	342	7.25	1149	6.75
Diff	3585	45	0.56	29	1.50
Diff %	13.10%			2.55%	

Standard Error: 259

Ave. Abs. Error: 175

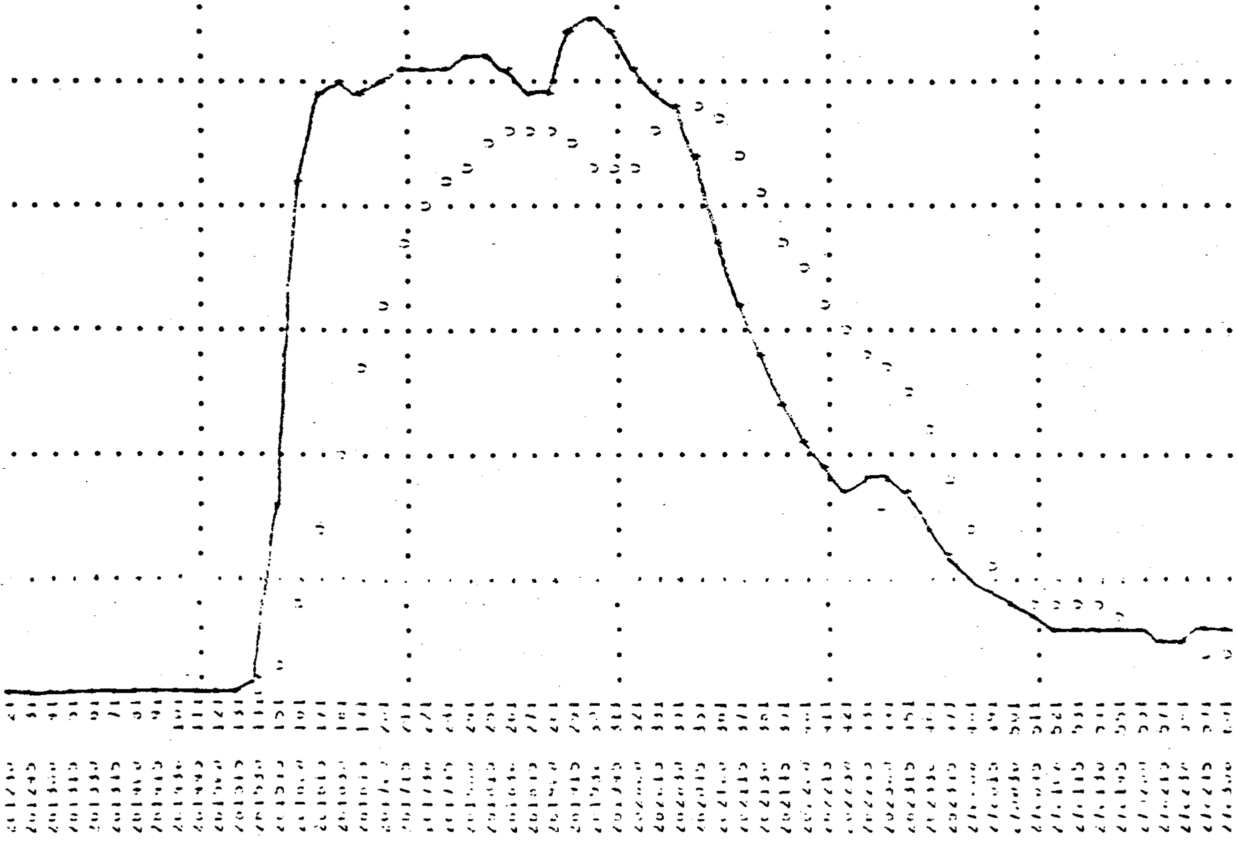
Ave. % Abs. Error: 67.95%.



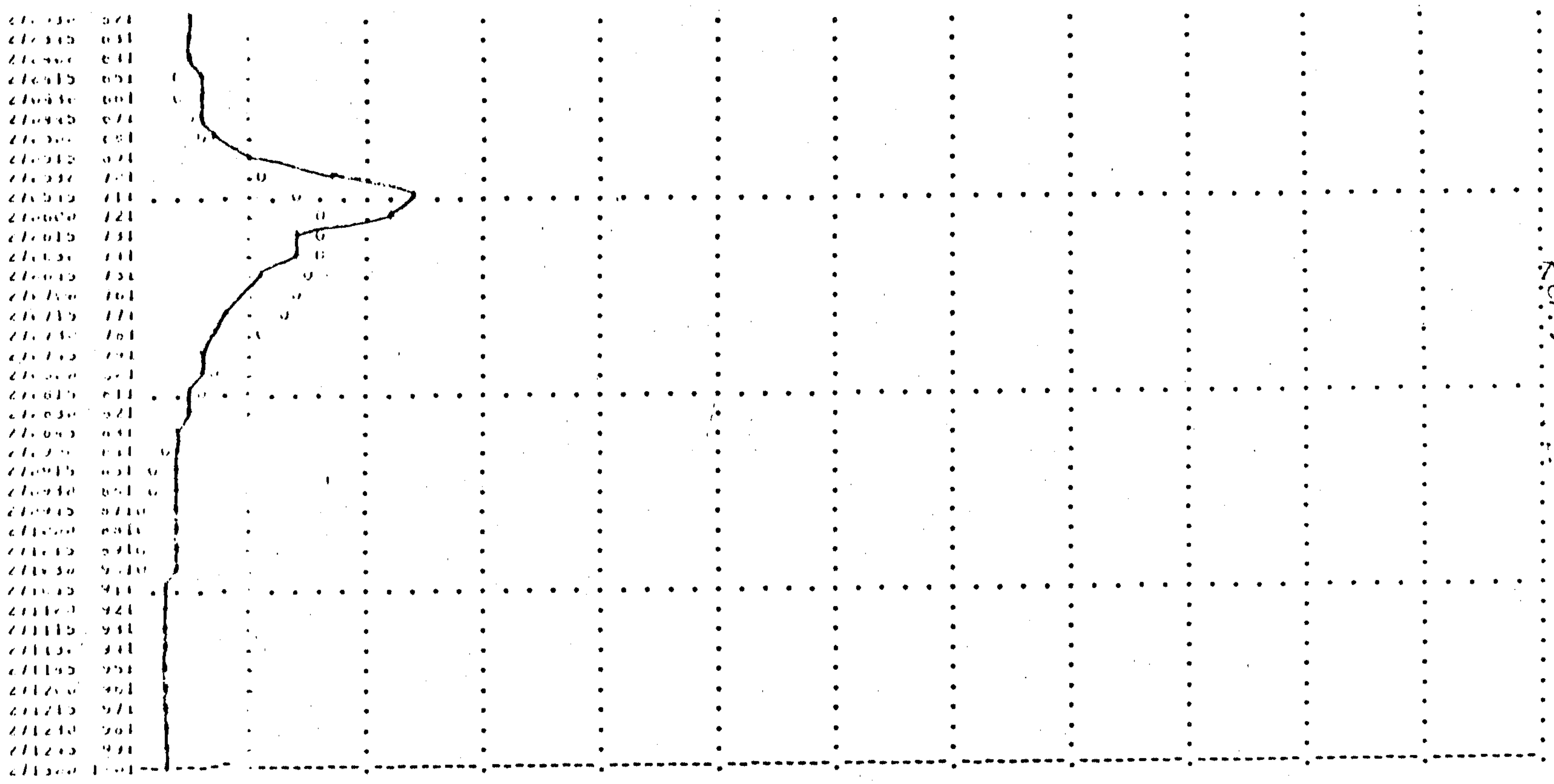
RUN 35 P1

STORM 2 · USE Tc, R from hydrographic Analysis

	Sum of flows	mean flow	Time to C.M.	peak flow	Time to peak
Computed	29448	294	9.75	965	8.50
Observed	32721	327	9.36	1099	7.25
Diff.	-3273	-33	0.40	-134	1.25
Diff %	-10.00 %			-12.00 %	
STANDARD ERROR	170				
Ave ABS Err	104				
Ave % ABS Er.	42.53 %				



Run: 35



106

```
                                    RUNOFF SUMMARY
                              FLOW IN CUBIC FEET PER SECOND
                            TIME IN HOURS,  AREA IN SQUARE MILES

                                  PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN    MAXIMUM    TIME OF
   OPERATION          STATION     FLOW    PEAK                                                 AREA     STAGE     MAX STAGE
                                                       6-HOUR      24-HOUR      72-HOUR

   HYDROGRAPH AT   +
                          40A     443.     7.25         260.         77.          75.          2.98

   ROUTED TO
                         1102     429.     7.75         258.         77.          75.          2.98

   HYDROGRAPH AT   +
                          40B     101.     3.75          76.         26.          25.          0.36

   HYDROGRAPH AT   +
                  [illegible]       2.     7.00           0.          0.           0.          0.7[illegible]
```

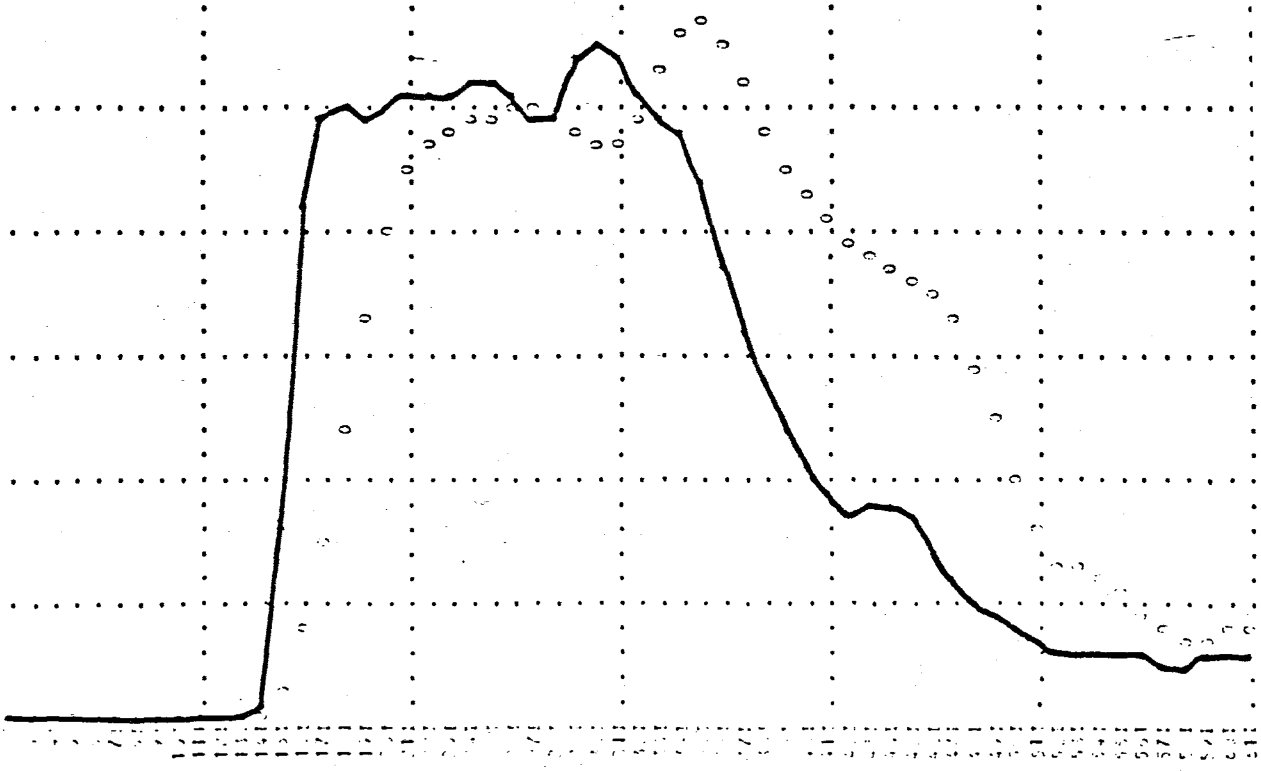
Run 35-1 P1

Storm #2 (Theissen)

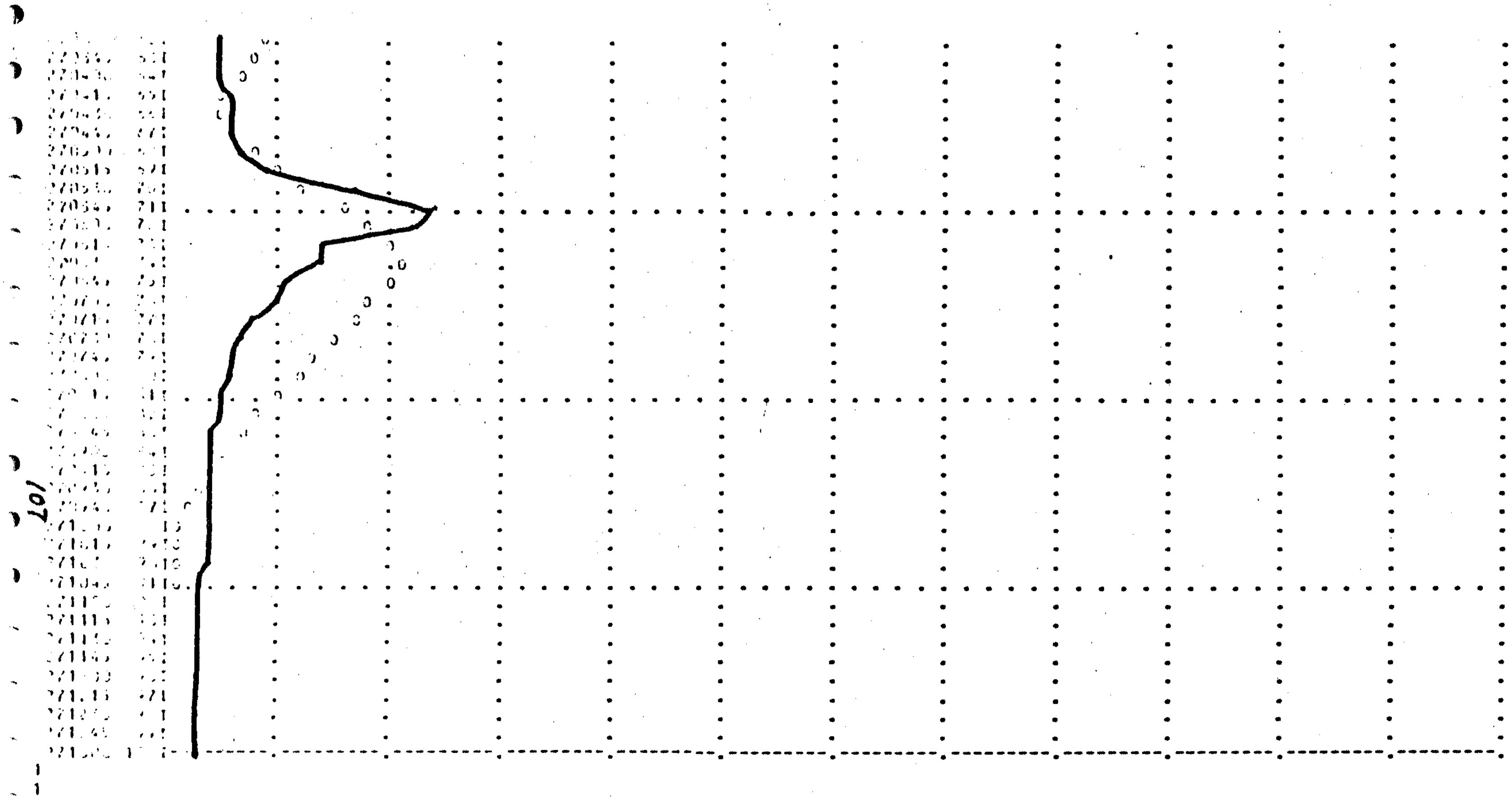
* Run 35 is storm #2 by Isohyetal.

	Sum of flows	Mean flow	Time to C.M.	Peak Flow	Time to peak
Computed	36954	370	10.12	1141	8.50
Observed	32721	327	9.56	1099	7.25
Diff.	4233	42	0.76	42	1.25
Diff %	12.94%			3.78%	

Standard Error = 207
Ave. Abs Error: 136
Ave. % Abs. Error: 62.11%



Run 35-1 Pg.



107

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	[illegible]	557.	7.25	277.	95.	92.	2.98		
ROUTED TO	1102	450.	7.75	275.	95.	92.	2.98		
HYDROGRAPH AT	OOH	155.	3.50	90.	31.	30.	0.38		
HYDROGRAPH AT	[illegible]	45.	7.25	10.	3.	3.	0.70		

RUN 36 P2

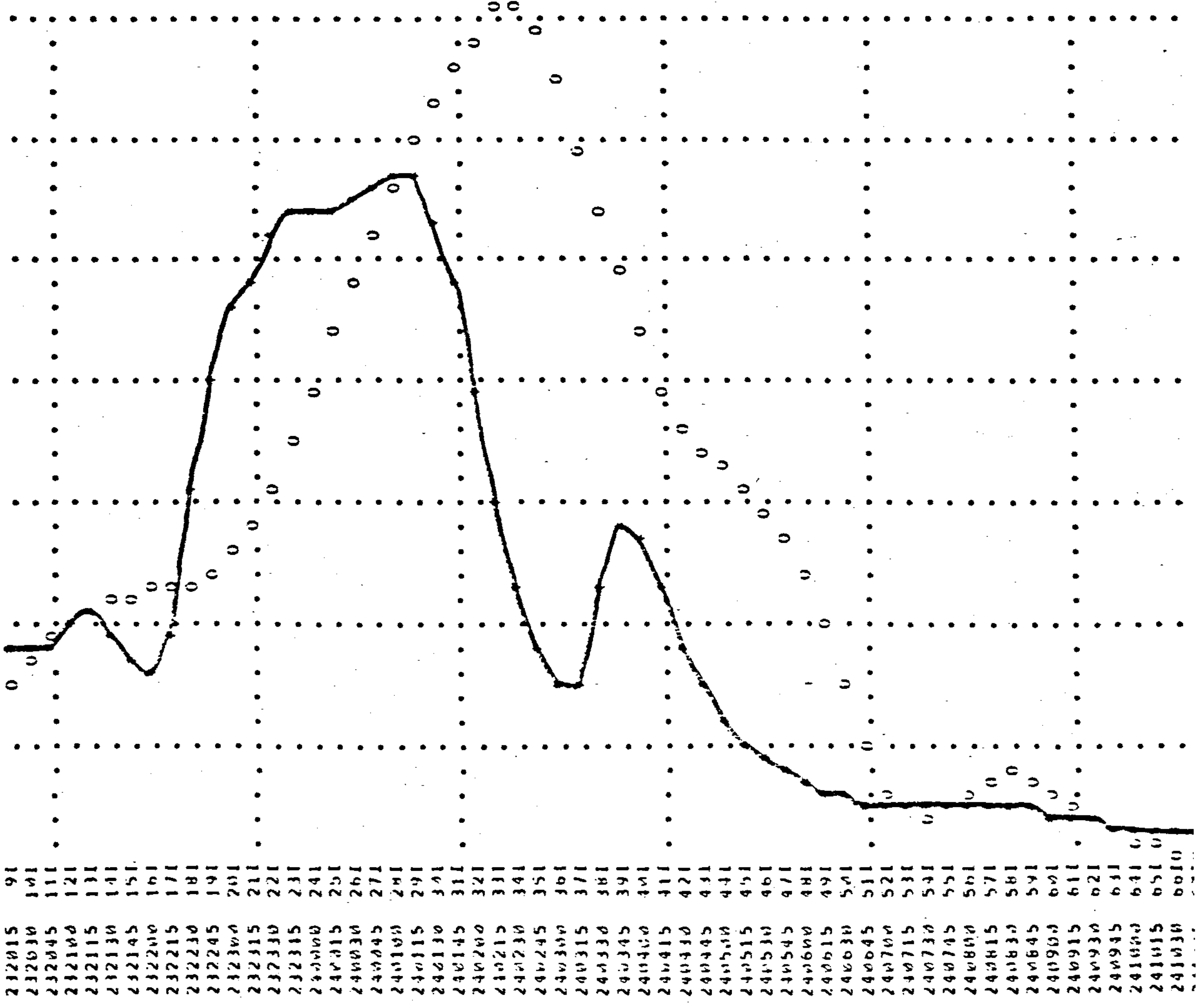
STORM 1

USE Same data as RUN 34. that is. Tc & R from hydrogr
Analysis.
NOW, STRKR value of Loss Rate (LE Card) are changed.

A 0.6→0.4
Bp 0.7→0.4
Hp 0.7→0.4
Jp 0.4→0.2
Ip 0.5→0.25
Mp 0.5→0.25
Lp 0.4→0.2
Np 0.5→0.25

All STRKRs of Impervious part
are not changed.

	Sum of Flows	mean Flow	Time to C.M.	Peak Flow	Time to Peak
Computed	34712	434	7.98	1422	8.25
observed	27370	342	7.25	1149	6.75
Diff.	7342	92	0.73	273	1.50
Diff. %	26.83%			23.74%	
Standard Error	314				
Ave Abs Error	194				
Ave. % Abs. Error	74.13%				



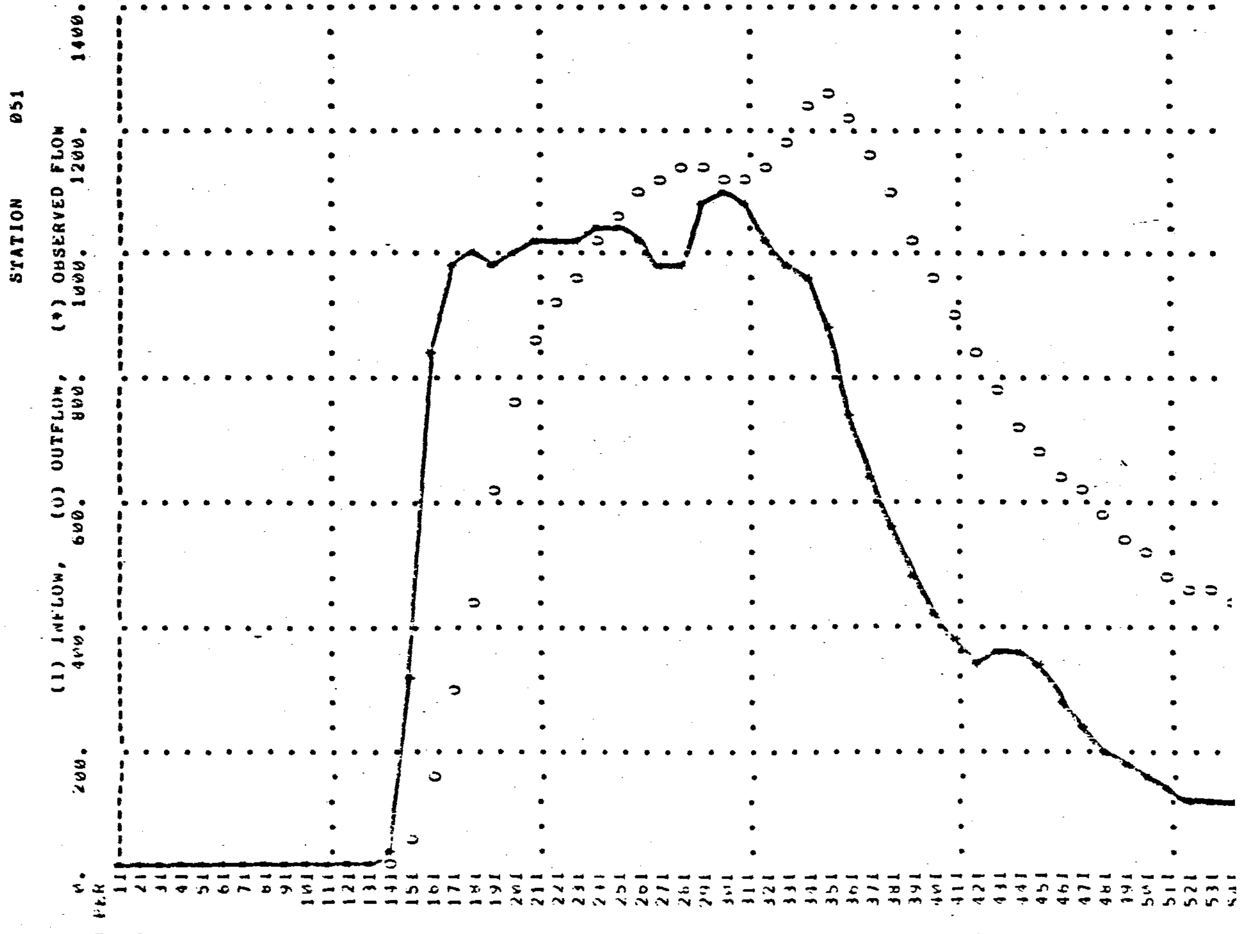
RUN 37 P1

STORM 2

USE same data as RUN36 to see what's the e
of reducing Loss Rate (STRKR)

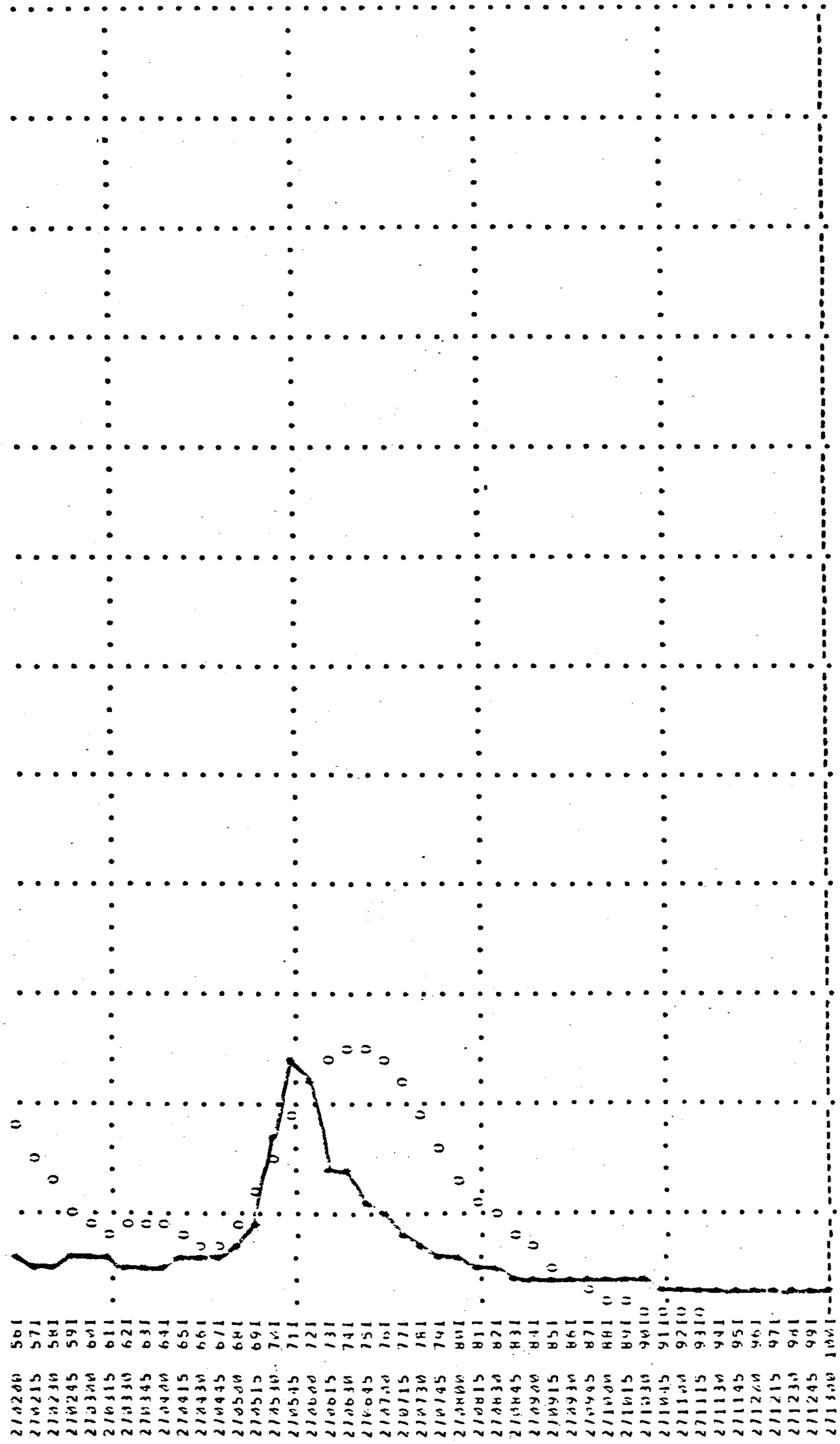
	Sum of Flow	mean Flow	Time to C.M.	peak Flow	Time of Peak
Computed	41869	419	10.44	1256	8.50
Observed	32721	327	9.36	1099	7.25
Diff	9148	91	1.08	157	1.25
Diff %	27.96%			14.27%	

Standard Error	245
Abs. Ave. Error	171
Abs. % Ave. Error	80.37%



109

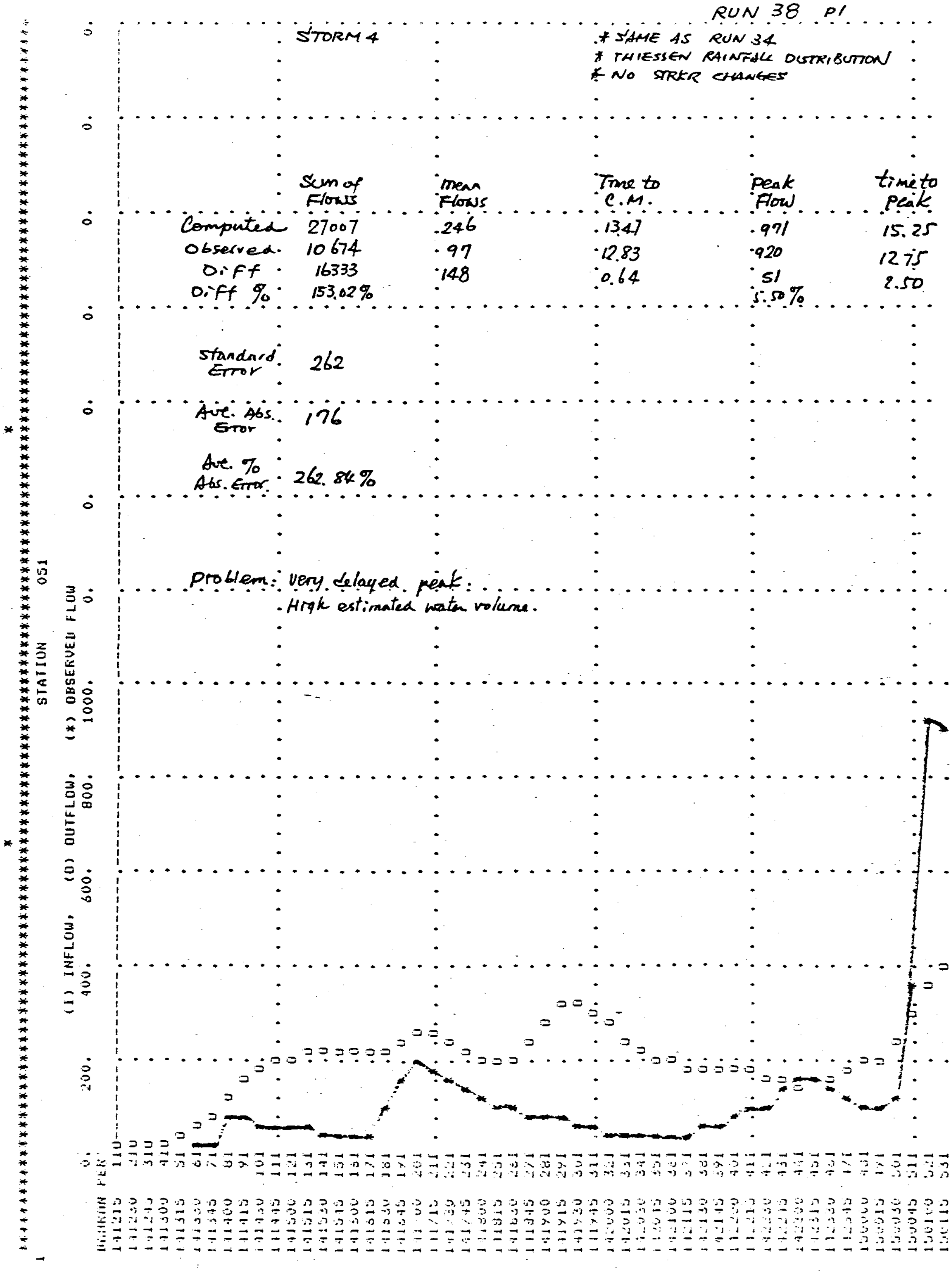
RUN 37 P2.



RUN 38 p1

STORM 4

* SAME AS RUN 34
* THIESSEN RAINFALL DISTRIBUTION
* NO STRKR CHANGES



	Sum of Flows	mean Flows	Time to C.M.	peak Flow	time to peak
Computed	27007	246	13.47	971	15.25
Observed	10674	97	12.83	920	12.75
Diff	16333	148	0.64	51	2.50
Diff %	153.02%			5.50%	

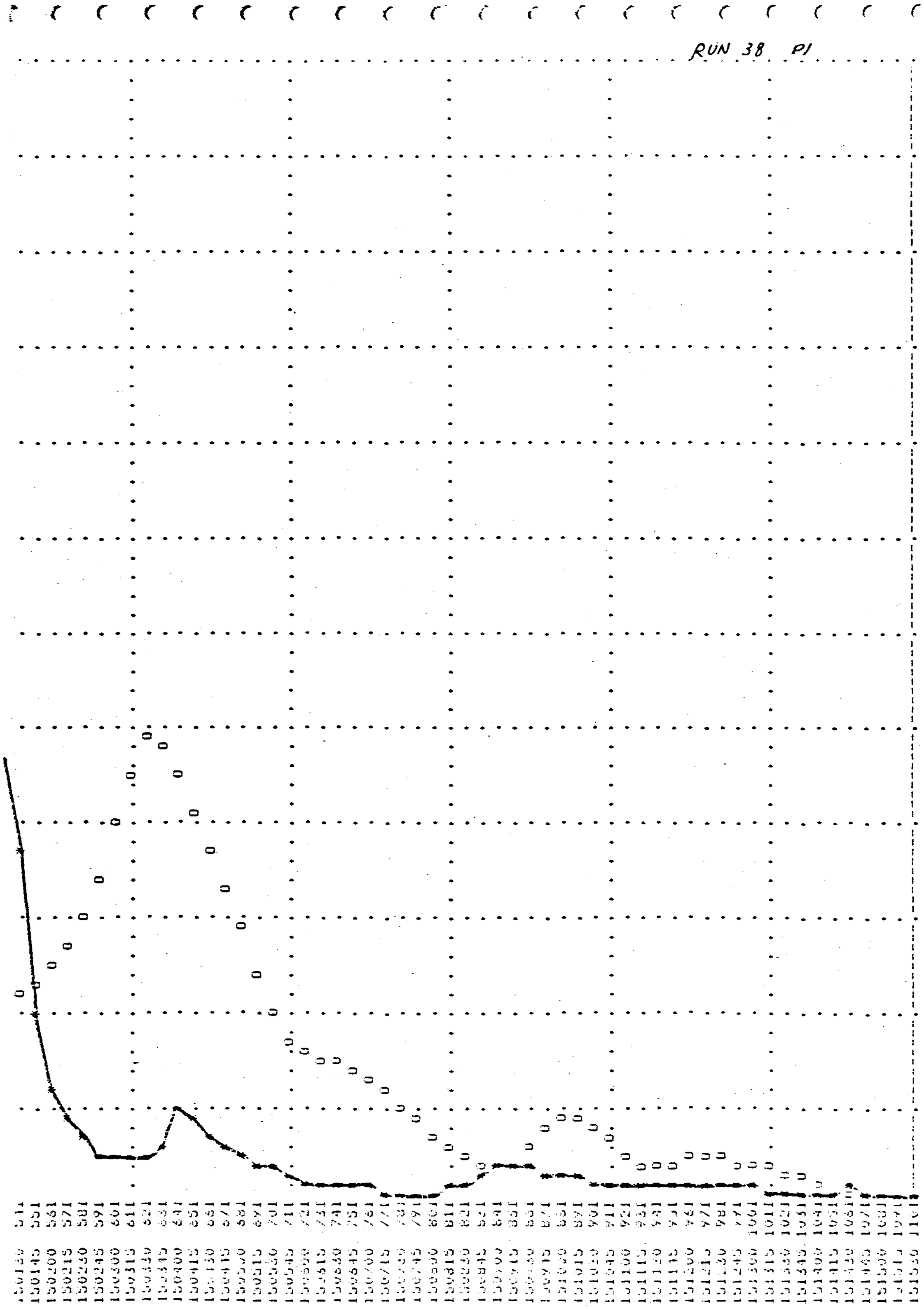
Standard Error 262

Ave. Abs. Error 176

Ave. % Abs. Error 262.84%

Problem: very delayed peak.
High estimated water volume.

RUN 38 P1



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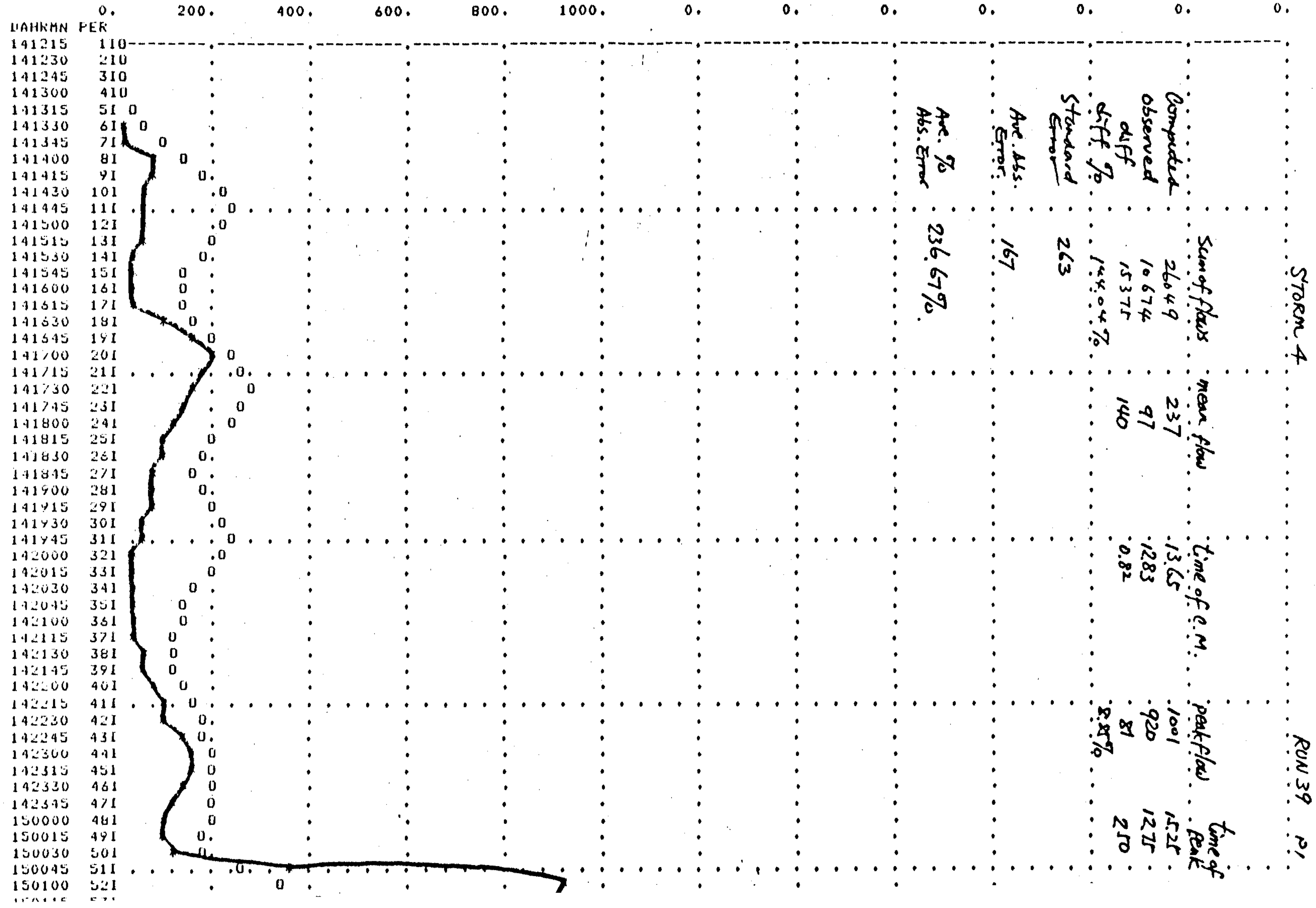
1                                                 STATION      051

                              (I) INFLOW,    (O) OUTFLOW,    (*) OBSERVED FLOW
```



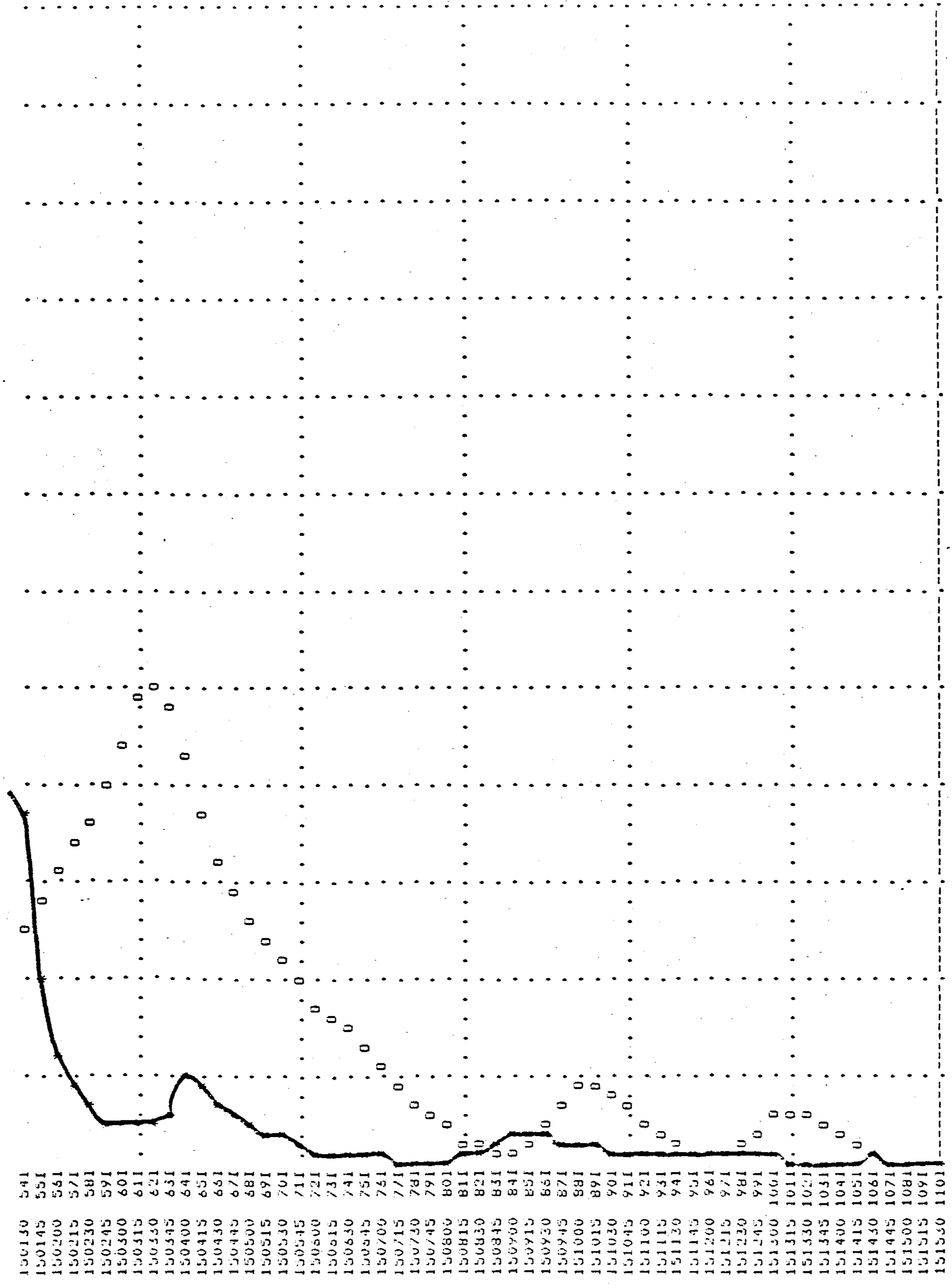
STORM 4

RUN 39 P1

	Sum of flows	mean flow	time of C.M.	peak flow	time of peak
Computed	26649	237	13.65	1001	1525
observed	10674	97	1283	920	1275
diff	15375	140	0.82	81	250
diff %	144.04%			8.8%	
Standard Error	263				
Ave. Abs. Error	167				
Ave. % Abs. Error	236.67%				

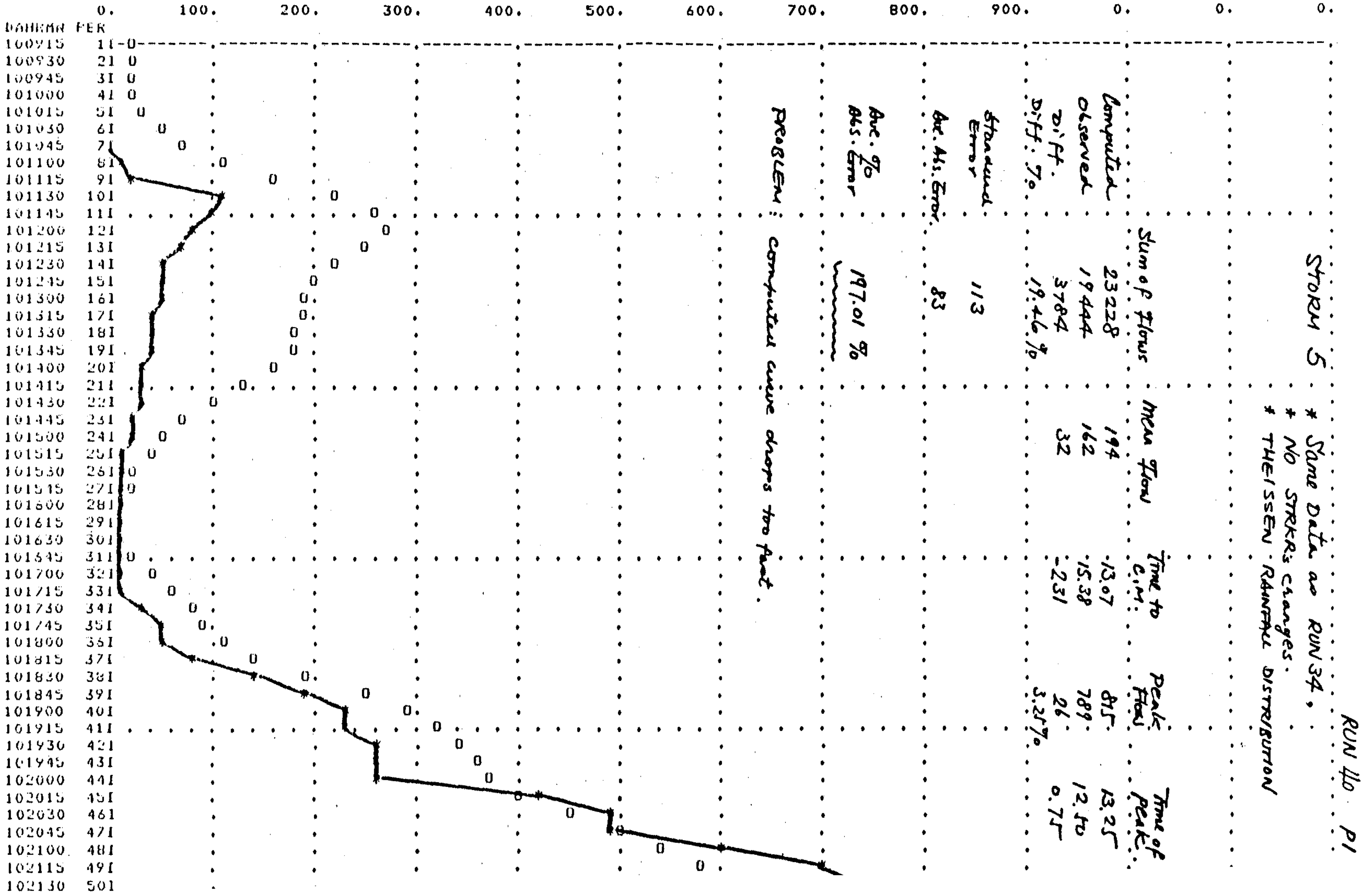
113

RUN 39 P2.


541 150130
551 150145
561 150200
571 150215
581 150230
591 150245
601 150300
611 150315
621 150330
631 150345
641 150400
651 150415
661 150430
671 150445
681 150500
691 150515
701 150530
711 150545
721 150600
731 150615
741 150630
751 150645
761 150700
771 150715
781 150730
791 150745
801 150800
811 150815
821 150830
831 150845
841 150900
851 150915
861 150930
871 150945
881 151000
891 151015
901 151030
911 151045
921 151100
931 151115
941 151130
951 151145
961 151200
971 151215
981 151230
991 151245
1001 151300
1011 151315
1021 151330
1031 151345
1041 151400
1051 151415
1061 151430
1071 151445
1081 151500
1091 151515
1101 151530

```
 10 APR 1830  38      192.      136.        56. * 11 APR 0430  78      352.      180.      172. * 11 APR 1430 118        0.       43.      -43.
 10 APR 1845  39      247.      192.        55. * 11 APR 0445  79      288.      150.      138. * 11 APR 1445 119        0.       41.      -41.
 10 APR 1900  40      291.      234.        57. * 11 APR 0500  80      223.      132.       91. * 11 APR 1500 120        0.       40.      -40.
                                                *                                              *
********************************************************************************************************************************************
1                                                                   STATION      051

                                     (I) INFLOW,    (O) OUTFLOW,    (*) OBSERVED FLOW
```



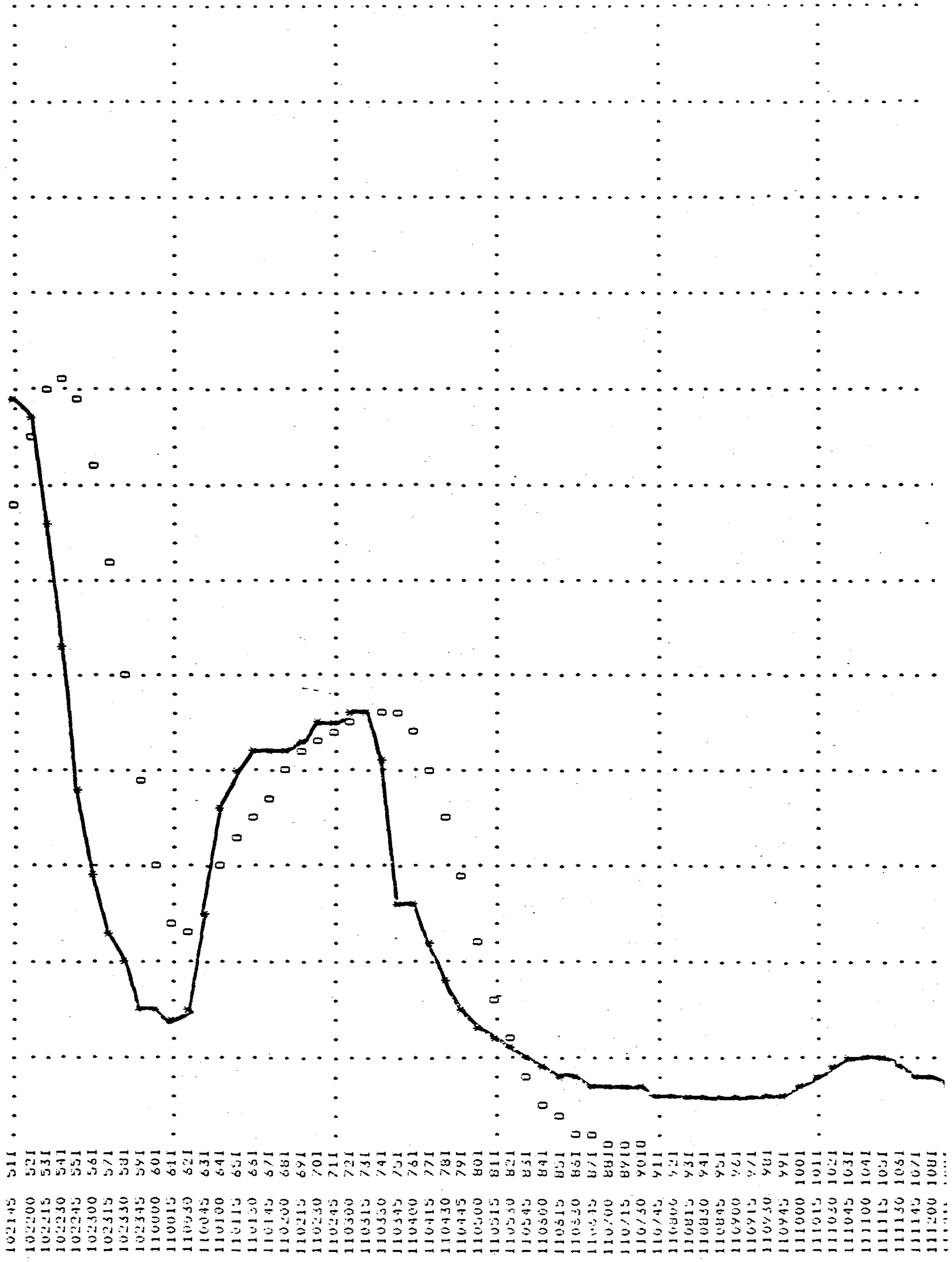
RUN 40 P1

STORM 5 * Same Data as RUN34.
* NO STRKRs changes.
* THEISSEN RAINFALL DISTRIBUTION

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time of Peak
Computed	23228	194	13.07	815	13.25
Observed	19444	162	15.38	789	12.50
Diff.	3784	32	-2.31	26	0.75
Diff. %	19.46 %			3.25 %	
Standard Error	113				
Ave. Abs. Error	83				
Ave. % Abs. Error	197.01 %				

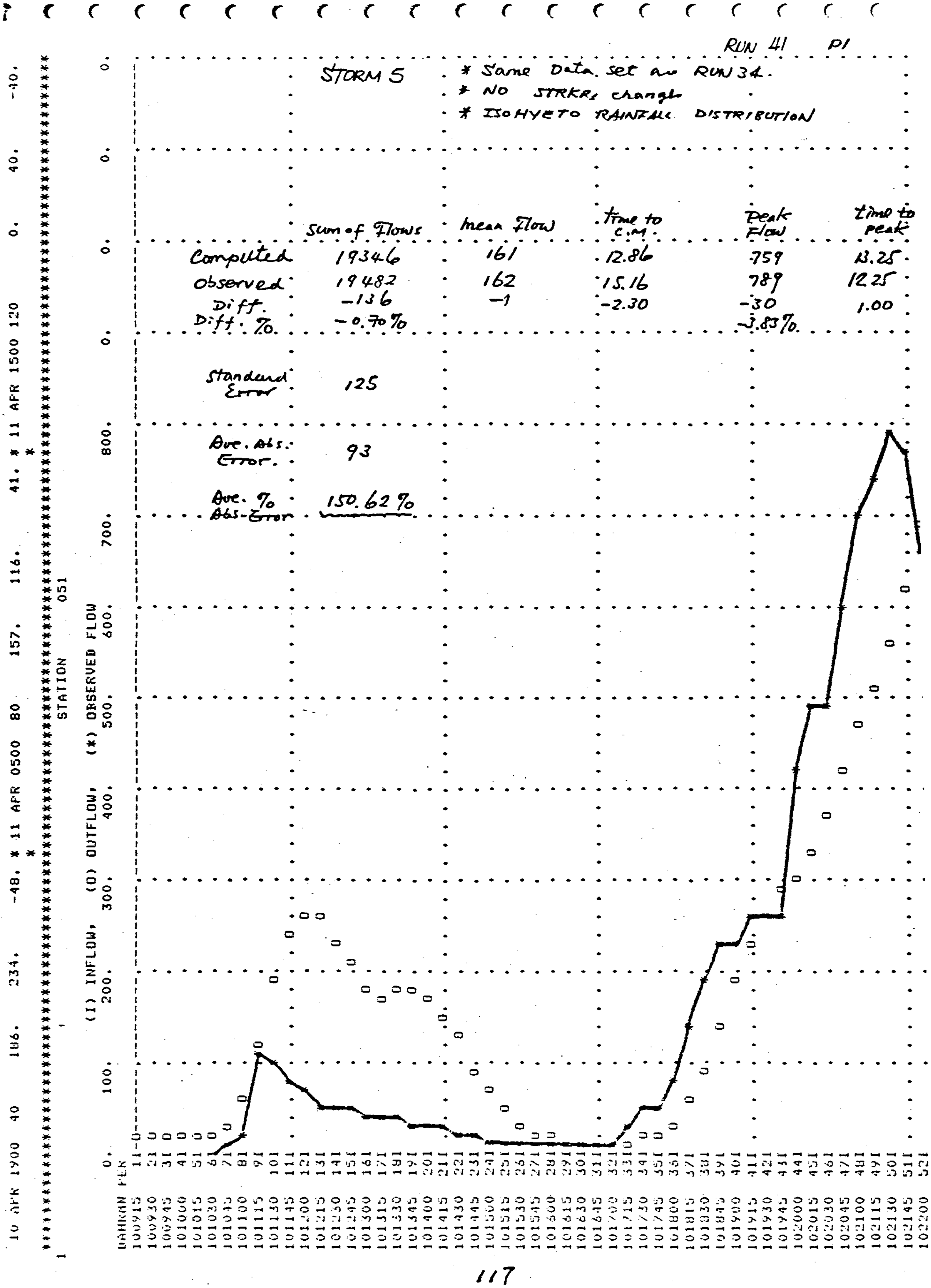
PROBLEM: computed curve drops too fast.

115


RUN 40 P2.

511 102145
521 102200
531 102215
541 102230
551 102245
561 102300
571 102315
581 102330
591 102345
601 110000
611 110015
621 110030
631 110045
641 110100
651 110115
661 110130
671 110145
681 110200
691 110215
701 110230
711 110245
721 110300
731 110315
741 110330
751 110345
761 110400
771 110415
781 110430
791 110445
801 110500
811 110515
821 110530
831 110545
841 110600
851 110615
861 110630
871 110645
8810 110700
8910 110715
9010 110730
911 110745
921 110800
931 110815
941 110830
951 110845
961 110900
971 110915
981 110930
991 110945
1001 111000
1011 111015
1021 111030
1031 111045
1041 111100
1051 111115
1061 111130
1071 111145
1081 111200

RUN 41 P1



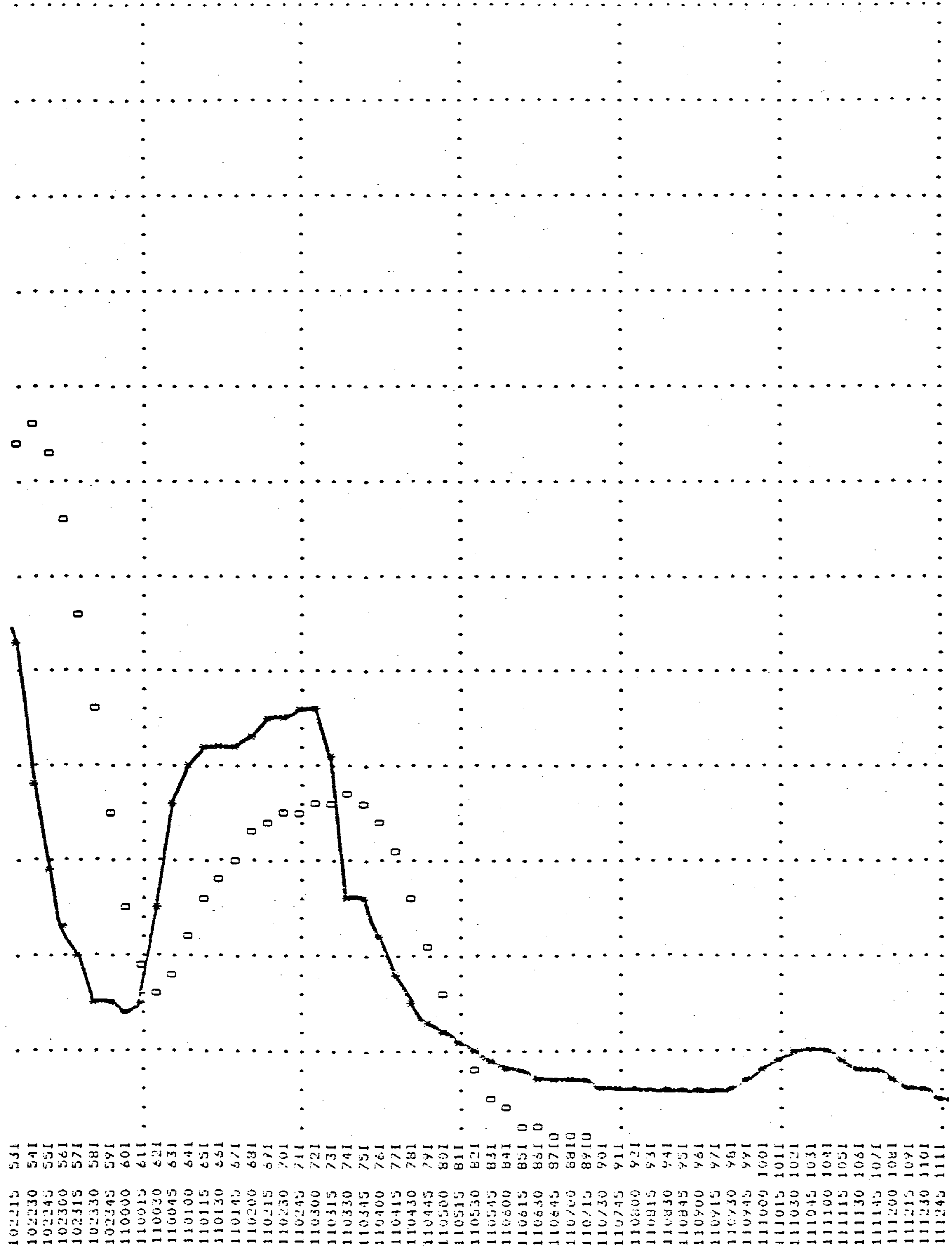
STORM 5

* Same Data set as RUN 34.
* NO STRKRs change
* ISOHYETO RAINFALL DISTRIBUTION

	Sum of Flows	mean Flow	time to C.M.	Peak Flow	time to peak
Computed	19346	161	12.86	759	13.25
Observed	19482	162	15.16	789	12.25
Diff.	-136	-1	-2.30	-30	1.00
Diff. %	-0.70%			-3.83%	

Standard Error	125
Ave. Abs. Error.	93
Ave. % Abs-Error	150.62%

RUN 41 P2



102215 531
102230 541
102245 551
102300 561
102315 571
102330 581
102345 591
110000 601
110015 611
110030 621
110045 631
110100 641
110115 651
110130 661
110145 671
110200 681
110215 691
110230 701
110245 711
110300 721
110315 731
110330 741
110345 751
110400 761
110415 771
110430 781
110445 791
110500 801
110515 811
110530 821
110545 831
110600 841
110615 851
110630 861
110645 871
110700 881
110715 891
110730 901
110745 911
110800 921
110815 931
110830 941
110845 951
110900 961
110915 971
110930 981
110945 991
111000 1001
111015 1011
111030 1021
111045 1031
111100 1041
111115 1051
111130 1061
111145 1071
111200 1081
111215 1091
111230 1101
111245 1111

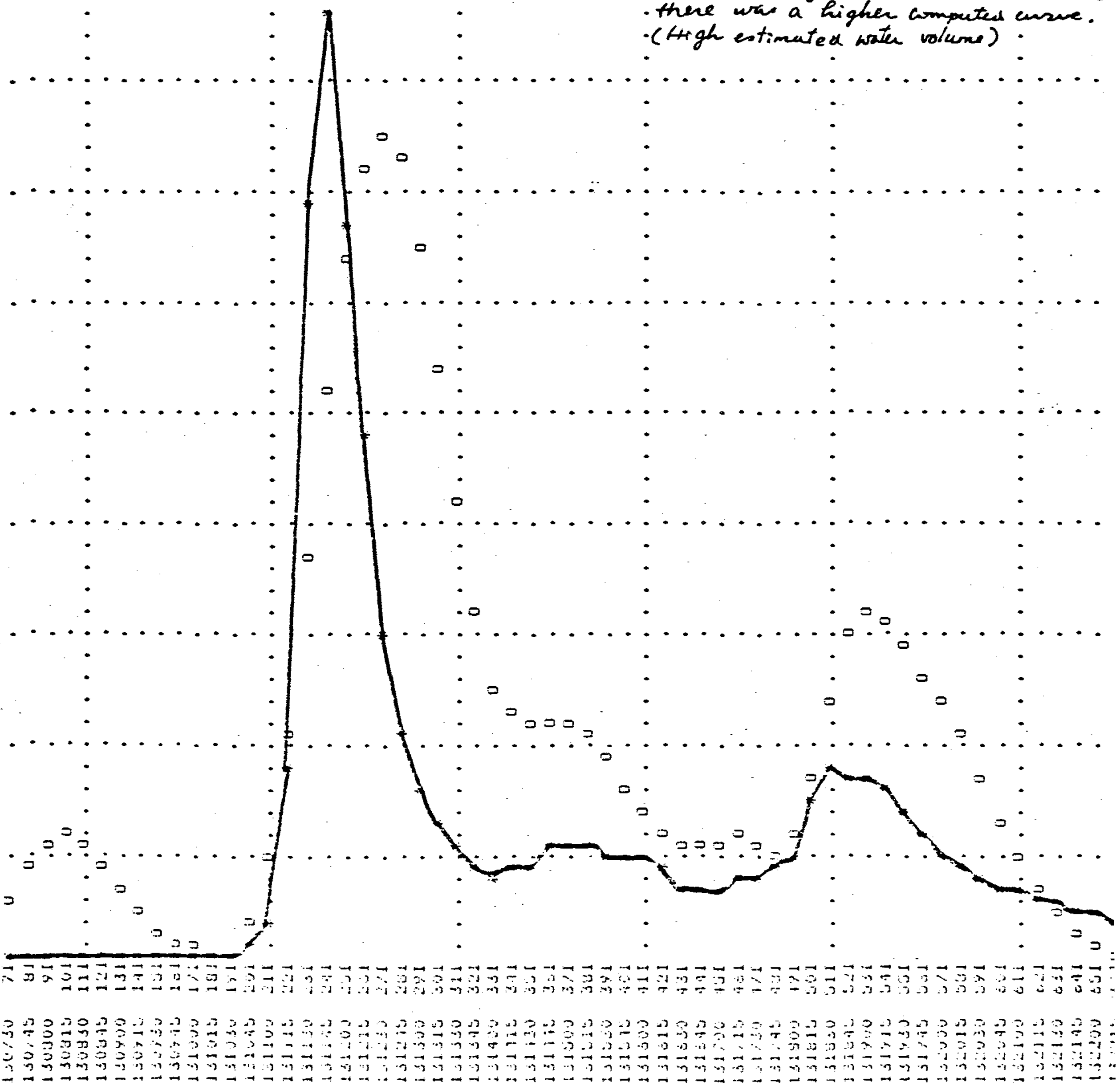
RUN 42 P1

STORM T

* Same Data as RUN 34
* No STRKR Changes
* THIESSEN RAINFALL DISTRIBUTION

	sum of flows	mean flow	time to C.M.	Peak flow	time of P
Computed	12618	175	8.78	754	6.50
Observed	7682	107	9.63	862	5.75
Diff.	4936	69	-0.25	-108	0.75
Diff %	64.25%			-12.56%	
Standard Error	151				
Ave. Abs. Error	95				
Ave. % Abs. Error	146.54%				

problem: more sensitive to rainfall.
While actually a small curve occurred there was a higher computed curve.
(High estimated water volume)

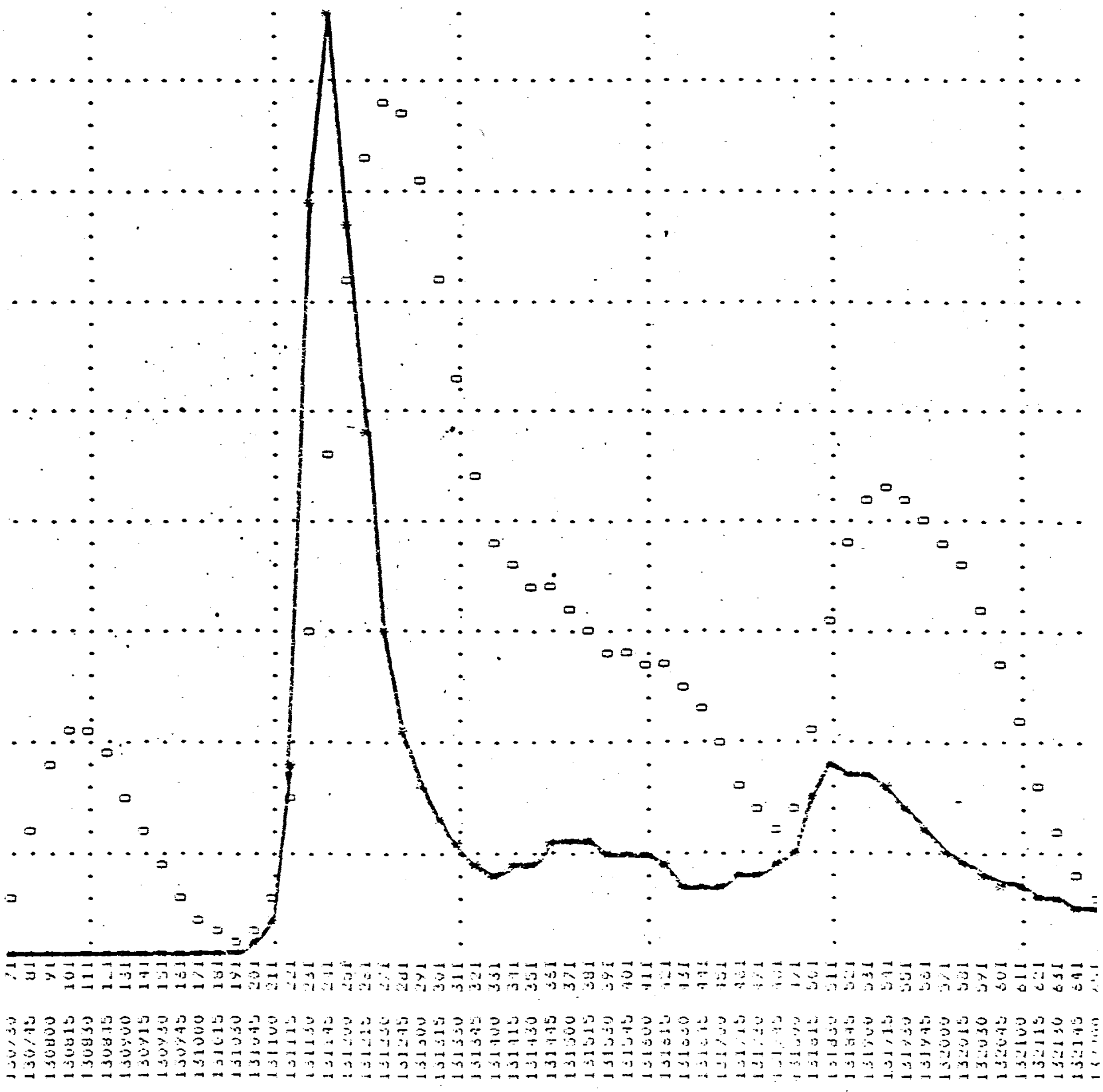


RUN 43

STORM 7

* SAME DATA AS RUN 34
* ISOHYETO RAINFALL DISTRIBUTION

	Sum of flows	mean flow	time to C.M.	Peak flow	time to peak
Computed	16870	234	9.24	781	6.50
observed	7682	107	9.03	862	5.75
Diff	9188	128	0.21	-81	0.75
Diff %	119.60%			-9.40%	
Standard Error	210				
~~Abs.~~ Ave. Error	156				
~~Abs.~~ % Ave. Abs. Error	268.65%				



120

```
 *   [illegible] HYDROGRAPH           22573.      1.305          342.       7.25          7.25        1149.        6.75     *
 *                                                                                                                          *
 *   [illegible]                      2153.       0.097           27.       0.41          0.41          24.        1.50     *
 *   PERCENT DIFFERENCE                7.27                                               5.66         2.08                 *
 *                                                                                                                          *
 *                    STANDARD ERROR         248.                   AVERAGE ABSOLUTE ERROR       164.                       *
 *                  OBJECTIVE FUNCTION       297.           AVERAGE PERCENT ABSOLUTE ERROR       60.87                      *
 *                                                                                                                          *
 ****************************************************************************************************************************

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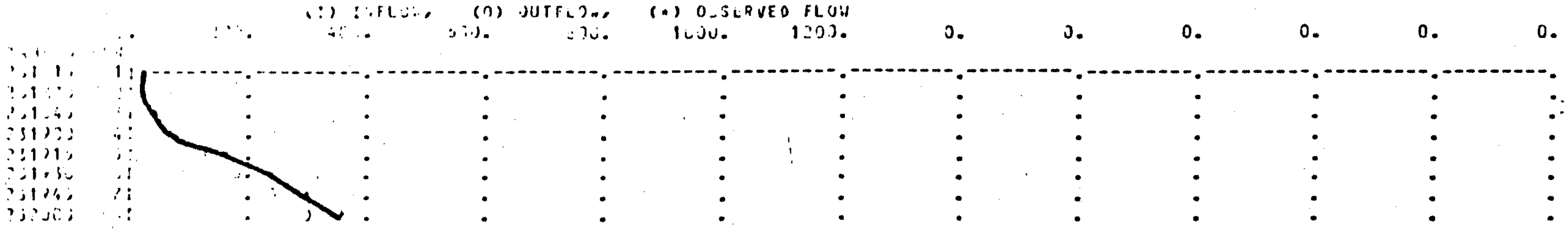
                                               HYDROGRAPH AT STATION      051

*******************************************************************************************************************************
                                          *                                                         *
 DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL * DA MON HRMN ORD     COMP Q    OBS Q   RESIDUL * DA MON HRMN ORD     COMP Q    OBS Q   RESIDUL
                                          *                                                         *
 [illegible]    1       1.       72.       -1. * 24 JAN 0100  28       887.    1149.     -262. * 24 JAN 0745  55       104.     107.       -3.
 [illegible]    2      71.       72.       -1. * 24 JAN 0115  29       927.    1134.     -207. * 24 JAN 0800  56       132.     107.       25.
 [illegible]    3      71.       32.       -1. * 24 JAN 0130  30       977.    1057.      -80. * 24 JAN 0815  57       149.     102.       47.
 [illegible]    4      71.       67.        4. * 24 JAN 0145  31      1042.     964.       78. * 24 JAN 0830  58       146.      90.       56.
 [illegible]    5     111.      1[illegible].  -57. * 24 JAN 0200  32      1116.     772.      344. * 24 JAN 0845  59       127.      90.       37.
 [illegible]    6     1[illegible]. 234.    -59. * 24 JAN 0215  33      1171.     608.      563. * 24 JAN 0900  60       101.      81.       20.
 [illegible]    7     [illegible] [illegible] -5[illegible]. * 24 JAN 0230  34  1173.  469.  704. * 24 JAN 0915  61  74.  81.  -7.
 [illegible]          [illegible] [illegible] -52.  * 24 JAN 0245  35      1115.     355.      750. * 24 JAN 0930  62        53.      77.      -24.
 [illegible]          [illegible] [illegible]  -6.  * 24 JAN 0300  36      1019.     301.      718. * 24 JAN 0945  63        36.      67.      -31.
 [illegible]   10     [illegible]  372.      62. * 24 JAN 0315  37       815.     301.      514. * 24 JAN 1000  64        25.      67.      -42.
 [illegible]   11     [illegible] [illegible] 55. * 24 JAN 0330  38       825.     450.      355. * 24 JAN 1015  65        17.      67.      -50.
 [illegible]   12     462.      405.       57. * 24 JAN 0345  39       754.     567.      187. * 24 JAN 1030  66        11.      65.      -54.
 [illegible]   13     475.      416.       41. * 24 JAN 0400  40       705.     538.      167. * 24 JAN 1045  67         7.      61.      -54.
 [illegible]   14     [illegible]  334.      51. * 24 JAN 0415  41       677.     458.      219. * 24 JAN 1100  68         5.      59.      -54.
 [illegible]   15     472.      331.      141. * 24 JAN 0430  42       563.     355.      295. * 24 JAN 1115  69         3.      59.      -56.
 [illegible]   16     [illegible]  311.      15[illegible]. * 24 JAN 0445  43   543.   299.   344. * 24 JAN 1130  70   2.   59.  -57.
 [illegible]   17     [illegible] [illegible] 59. * 24 JAN 0500  44       607.     245.      362. * 24 JAN 1145  71         1.      57.      -56.
 [illegible]   18     [illegible]  529.     -199. * 24 JAN 0515  45       550.     202.      343. * 24 JAN 1200  72         1.      55.      -54.
 [illegible]   19     [illegible]  727.     -357. * 24 JAN 0530  46       478.     175.      303. * 24 JAN 1215  73         1.      55.      -54.
 [illegible]          [illegible]  912.     -453. * 24 JAN 0545  47       391.     151.      240. * 24 JAN 1230  74         0.      51.      -51.
 [illegible]   21     [illegible]  [illegible] -457. * 24 JAN 0600  48       291.     136.      155. * 24 JAN 1245  75         0.      51.      -51.
 [illegible]          [illegible] 1034.     -479. * 24 JAN 0615  49       193.     115.       82. * 24 JAN 1300  76         0.      51.      -51.
 [illegible]   2      [illegible] 1070.     -457. * 24 JAN 0630  50       131.     116.       15. * 24 JAN 1315  77         0.      49.      -49.
 [illegible]          [illegible] 1074.     -375. * 24 JAN 0645  51        88.     103.      -20. * 24 JAN 1330  78         0.      49.      -49.
 [illegible]          [illegible] 1072.     -315. * 24 JAN 0700  52        64.     101.      -37. * 24 JAN 1345  79         0.      46.      -46.
 [illegible]          [illegible] 1239.     -337. * 24 JAN 0715  53        62.      99.      -37. * 24 JAN 1400  80         0.      40.      -40.
 [illegible]   27     [illegible] 1127.     -273. * 24 JAN 0730  54        78.      99.      -21. *
                                          *                                                         *
*******************************************************************************************************************************
1                                                              STATION       051
```

121



Run K

STORM 44 P2

STORM #1 (THEISSEN) Compare with 34 -

	Sum of flows	mean flow	Time to c.m.	peak flow	Time to peak
Computed	29553	369	7.66	1173	8.25
observed	27370	342	7.25	1149	6.75
Diff	2183	27	0.41	24	1.50
Diff %	7.97%			2.08%	

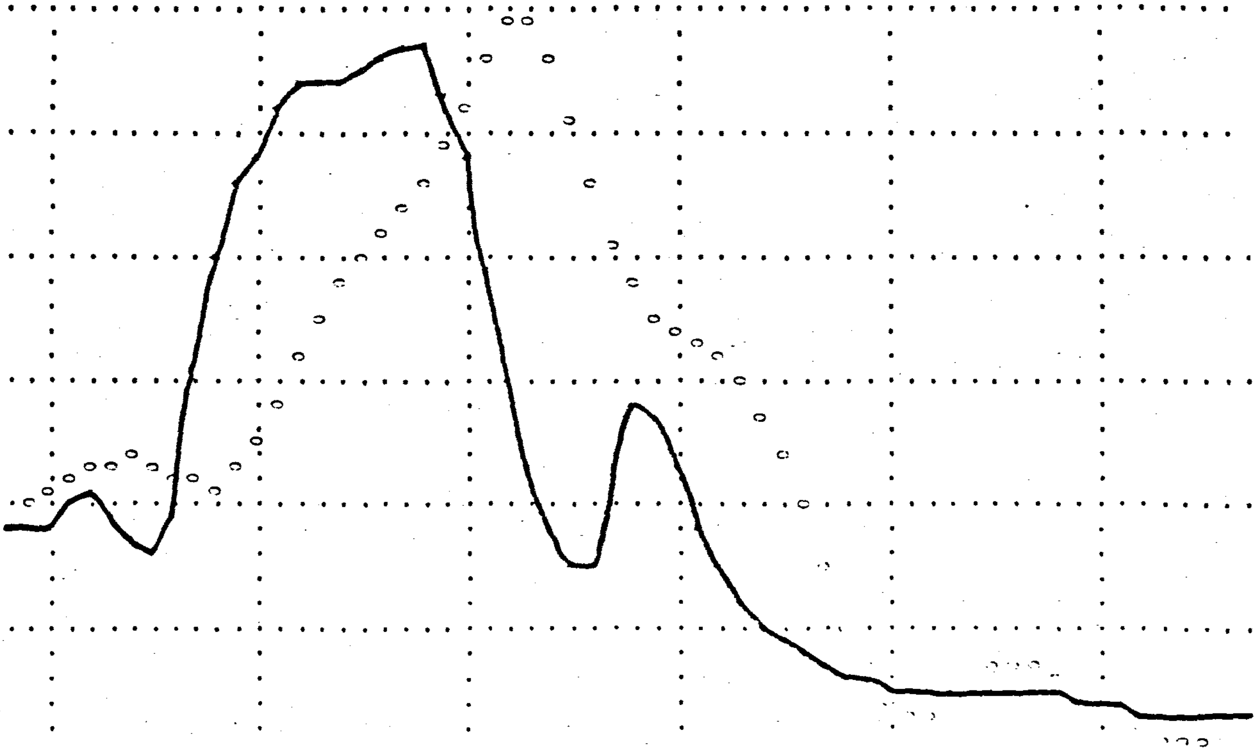
Standard Error: 248

Ave. Abs. Error: 164

Ave. % Abs. Error 60.87%

Changes: from Run 44 to Run 53

	STRKR	DLTKR
A	0.6→0.6	1.3→1.4
Bp	0.7→0.8	1.36→1.6
Hp	0.7→0.8	1.51→1.6
Ip	0.5→0.6	0.96→1.2
Jp	0.4→0.5	0.75→1.0
Mp	0.5→0.5	0.95→1.0
Lp	0.4→0.5	0.8→1.0
NR	0.5→0.5	0.92→1.0



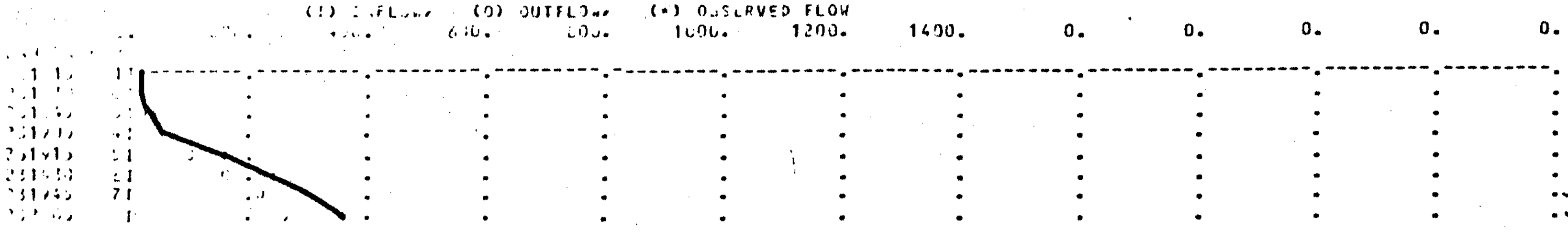
```
*   [illegible]                  [illegible]    1.9[illegible]     342.      7.25      7.25      1149.      6.75     *
*                                                                                                              *
*   DIFFERENCE                   -1432.        -0.057      -18.      0.02      0.02        79.      1.25     *
*   PERCENT DIFFERENCE           -5.23                                         0.34        6.83              *
*                                 -1.45                                                                        *
*              STANDARD ERROR     220.234              AVERAGE ABSOLUTE ERROR      129.                       *
*          OBJECTIVE FUNCTION     265.         AVERAGE PERCENT ABSOLUTE ERROR      49.19   = 2.68.            *
*                                                                                                              *
****************************************************************************************************************

***********************************************************************************************************************

                                           HYDROGRAPH AT STATION      051

***********************************************************************************************************************
                                                 *                                                     *
 DA MON HRMN ORD    COMP Q     OBS Q   RESIDUL  * DA MON HRMN ORD    COMP Q     OBS Q   RESIDUL  * DA MON HRMN ORD    COMP Q     OBS Q   RESIDUL
                                                 *                                                     *
 23 JAN 1815   1       21.        22.        -1.  * 24 JAN 0100  28      971.     1149.      -178.  * 24 JAN 0745  55       70.      107.       -37.
 23 JAN 1830   2       21.        22.        -1.  * 24 JAN 0115  29     1036.     1134.       -98.  * 24 JAN 0800  56       96.      107.       -11.
 23 JAN 1845   3  [illegible]     32.        -4.  * 24 JAN 0130  30     1077.     1047.        30.  * 24 JAN 0815  57      113.      102.        11.
 23 JAN 1900   4  [illegible] [illegible]    -5.  * 24 JAN 0145  31     1155.      964.       191.  * 24 JAN 0830  58      115.       90.        25.
 23 JAN 1915   5  [illegible]    130.       -35.  * 24 JAN 0200  32     1207.      772.       435.  * 24 JAN 0845  59      103.       90.        13.
 23 JAN 1930   6      172.       234.       -62.  * 24 JAN 0215  33     1228.      608.       620.  * 24 JAN 0900  60       83.       81.         2.
 23 JAN 1945   7      214.  [illegible]     -35.  * 24 JAN 0230  34     1186.      469.       717.  * 24 JAN 0915  61       62.       81.       -19.
 23 JAN 2000   8  [illegible] [illegible]   -55.  * 24 JAN 0245  35     1072.      365.       707.  * 24 JAN 0930  62       44.       77.       -33.
 23 JAN 2015   9      317.       359.       -42.  * 24 JAN 0300  36      918.      301.       617.  * 24 JAN 0945  63       31.       67.       -36.
 23 JAN 2030  10  [illegible] [illegible]     5.  * 24 JAN 0315  37      765.      301.       464.  * 24 JAN 1000  64       21.       67.       -46.
 23 JAN 2045  11      383.       369.        14.  * 24 JAN 0330  38      639.      460.       179.  * 24 JAN 1015  65       14.       67.       -53.
 23 JAN 2100  12  [illegible]    405.  [illegible] * 24 JAN 0345  39      548.      567.       -19.  * 24 JAN 1030  66        9.       65.       -56.
 23 JAN 2115  13      414.       414.         0.  * 24 JAN 0400  40      484.      538.       -54.  * 24 JAN 1045  67        6.       61.       -55.
 23 JAN 2130  14      417.       364.        53.  * 24 JAN 0415  41      432.      453.       -19.  * 24 JAN 1100  68        4.       59.       -55.
 23 JAN 2145  15  [illegible]    331.        84.  * 24 JAN 0430  42      402.      365.        37.  * 24 JAN 1115  69        3.       59.       -56.
 23 JAN 2200  16      406.       312.        94.  * 24 JAN 0445  43      360.      299.        61.  * 24 JAN 1130  70        2.       59.       -57.
 23 JAN 2215  17  [illegible] [illegible]     4.  * 24 JAN 0500  44      310.      245.        65.  * 24 JAN 1145  71        1.       57.       -56.
 23 JAN 2230  18  [illegible]    629.      -239.  * 24 JAN 0515  45      243.      202.        41.  * 24 JAN 1200  72        1.       55.       -54.
 23 JAN 2245  19      403.       777.      -374.  * 24 JAN 0530  46      178.      175.         3.  * 24 JAN 1215  73        0.       55.       -55.
 23 JAN 2300  20      411.       812.      -401.  * 24 JAN 0545  47      125.      151.       -26.  * 24 JAN 1230  74        0.       51.       -51.
 23 JAN 2315  21  [illegible]    919.      -490.  * 24 JAN 0600  48       86.      136.       -50.  * 24 JAN 1245  75        0.       51.       -51.
 23 JAN 2330  22      565.      1034.      -469.  * 24 JAN 0615  49       58.      116.       -58.  * 24 JAN 1300  76        0.       51.       -51.
 23 JAN 2345  23  [illegible] [illegible]  -441.  * 24 JAN 0630  50       39.      116.       -77.  * 24 JAN 1315  77        0.       49.       -49.
 24 JAN 0000  24      716.      1074.      -358.  * 24 JAN 0645  51       26.      108.       -82.  * 24 JAN 1330  78        0.       49.       -49.
 24 JAN 0015  25      727.  [illegible]    -265.  * 24 JAN 0700  52       22.      101.       -79.  * 24 JAN 1345  79        0.       46.       -46.
 24 JAN 0030  26  [illegible]   1083.      -246.  * 24 JAN 0715  53       30.       99.       -69.  * 24 JAN 1400  80        0.       40.       -40.
 24 JAN 0045  27      857.      1177.      -320.  * 24 JAN 0730  54       47.       99.       -52.  *
                                                 *                                                     *
***********************************************************************************************************************
1                                                        STATION      051
```

123



RUN 45 P1

RUN 45 P2

Compare with 34

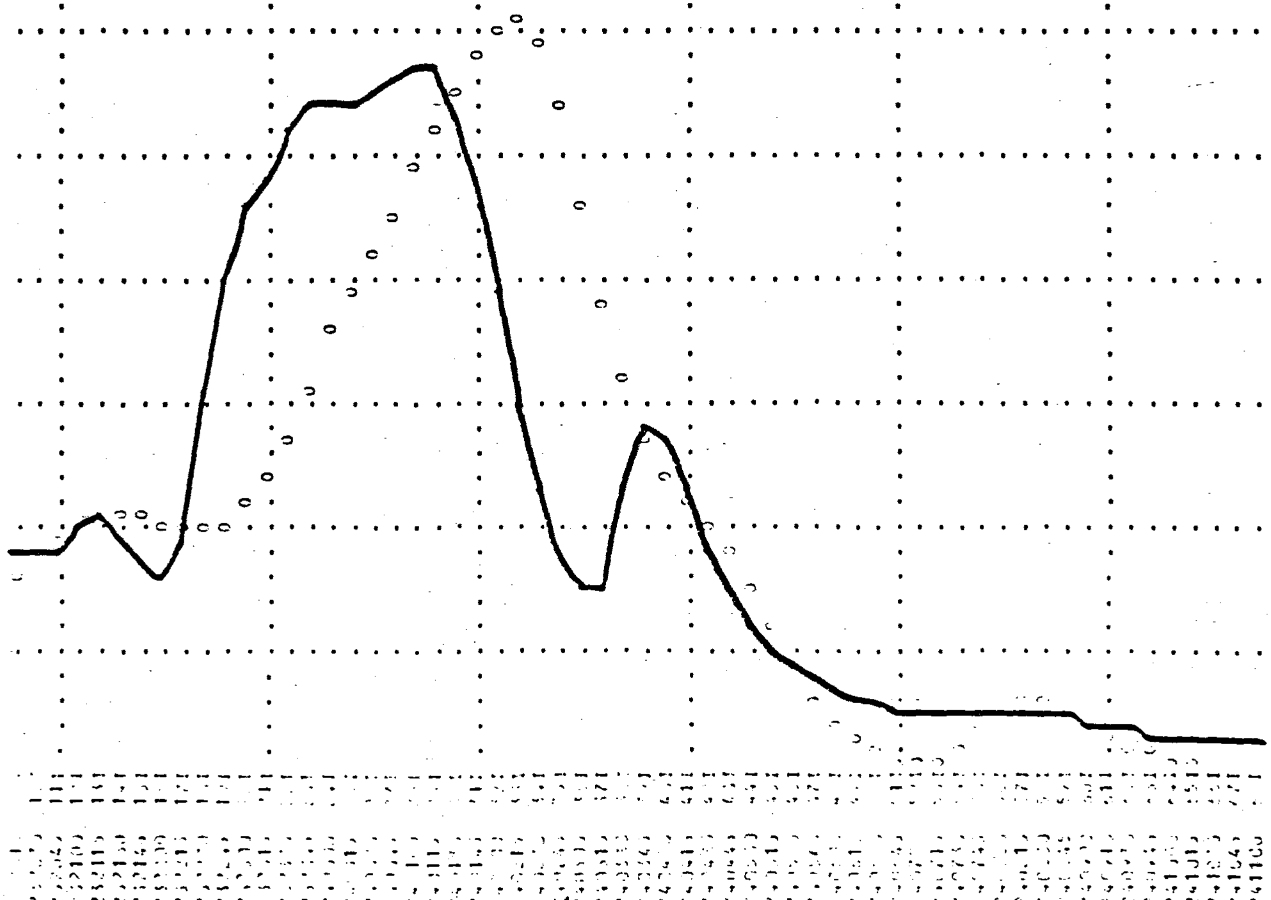
STORM #1. (ISOHYETAL)

	Sum of flows	mean flow	Time to C.M.	peak Flow	Time of peak
Computed	25938	324	7.27	1228	8.00
observed	27370	342	7.25	1149	6.75
Diff	-1432	-18	0.02	79	1.25
Diff %	-5.23%		0.34%	6.83%	

Standard error 220

Ave. Abs. error 129

Ave. % Abs. error 49.19 %

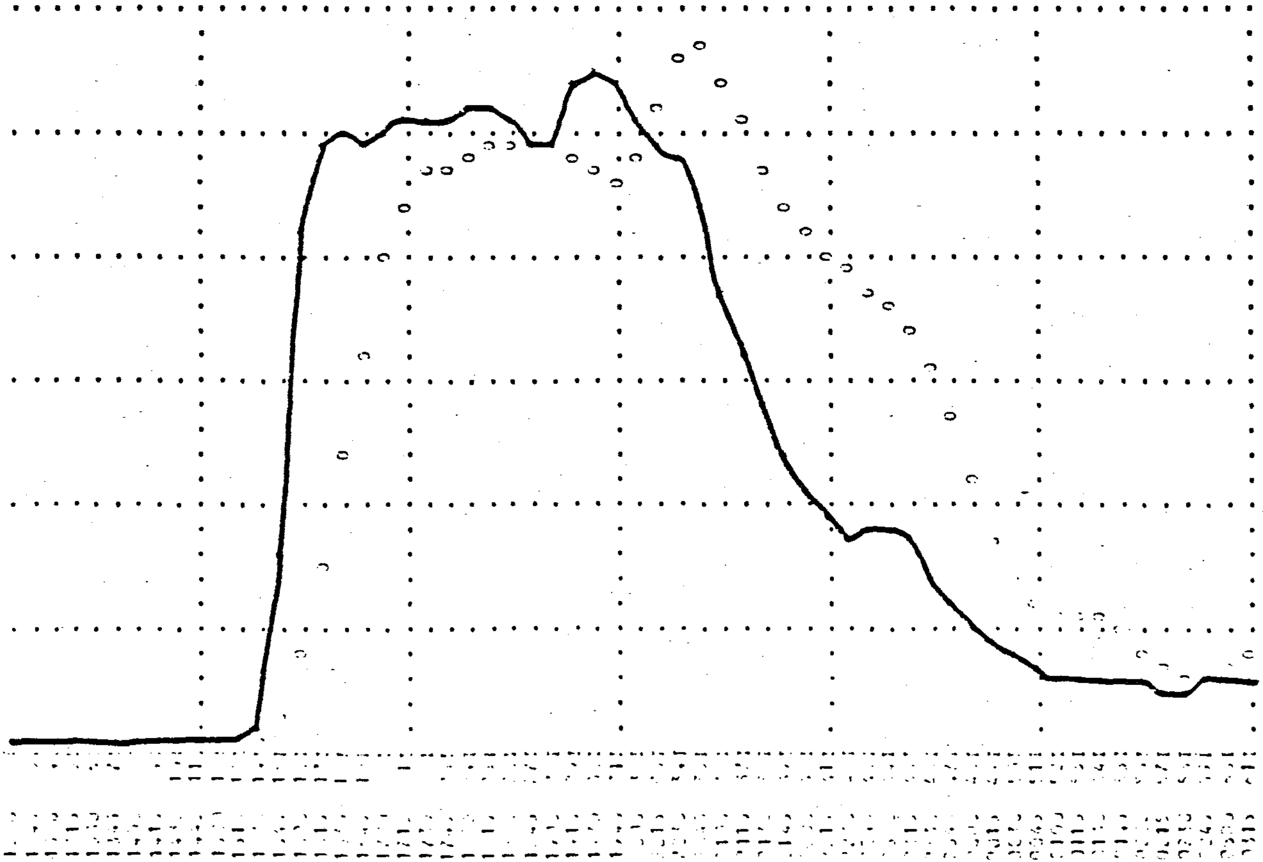


Run 66 P1

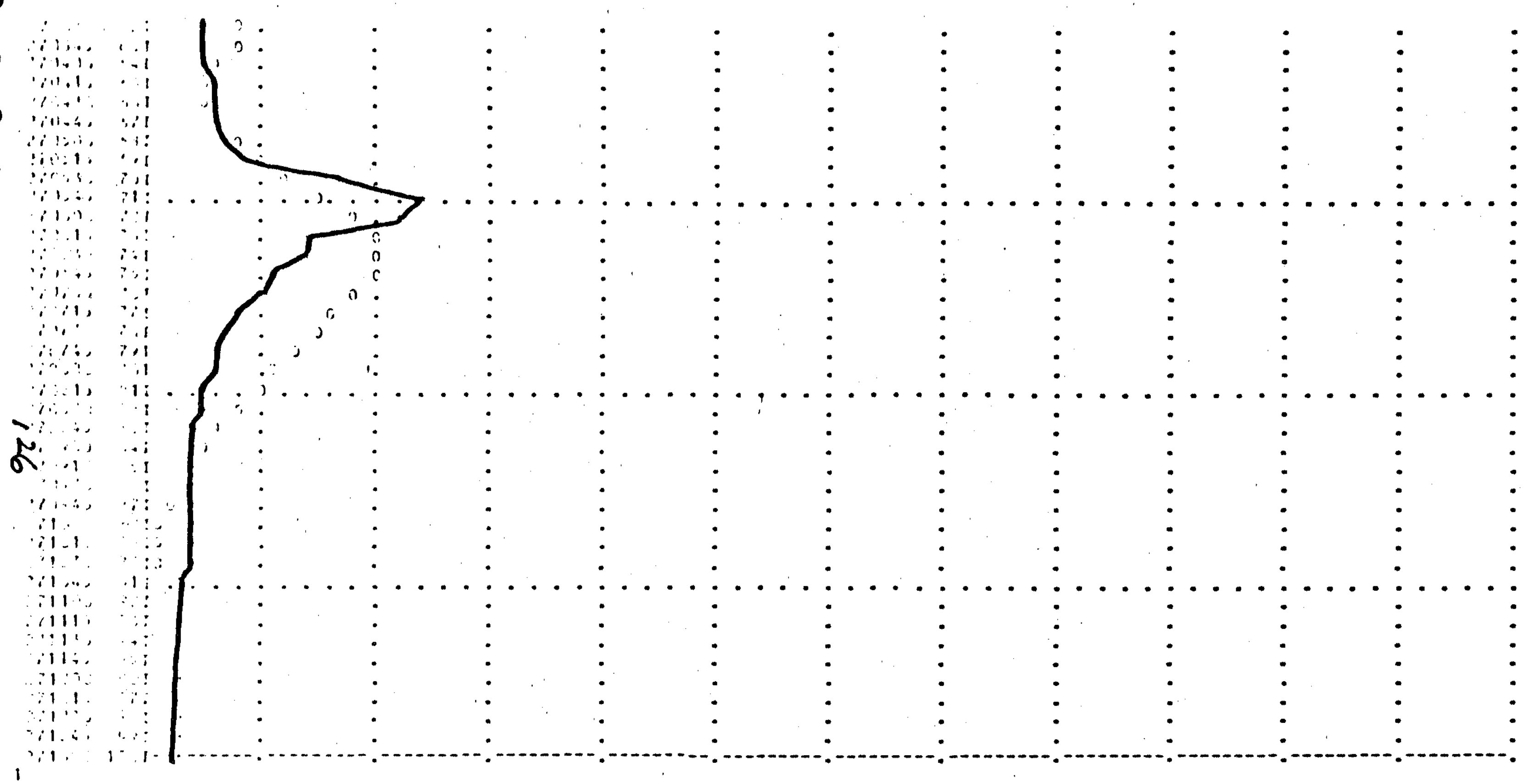
STORM #2 (Theissen)

Compare with IS-1

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to peak
Computed	35505	355	10.05	1130	8.50
Observed	32721	327	9.36	1099	7.25
Diff.	2784	28	0.69	31	1.25
Diff.%	8.51%			2.86%	
Standard Error :	194				
Ave. Abs. Error :	126				
Ave. % Abs. Error =	55.79%				



Run 46 p2



126

```
                                   RUNOFF SUMMARY
                            FLOW IN CUBIC FEET PER SECOND
                          TIME IN HOURS, AREA IN SQUARE MILES

                                 PEAK    TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD     BASIN   MAXIMUM   TIME OF
  [illegible]       STATION      FLOW     PEAK                                           AREA    STAGE   MAX STAGE
                                                    6-HOUR     24-HOUR     72-HOUR

  [illegible]
                   [illegible]   567.     7.25       273.        94.         91.        2.98

  [illegible]
                   [illegible]   431.     7.75       271.        94.         91.        2.98

  [illegible]
                   [illegible]   152.     5.50        90.        31.         30.        0.33

  [illegible]
```

RUN 47 p1

STORM #2 (ISOHYETALS)

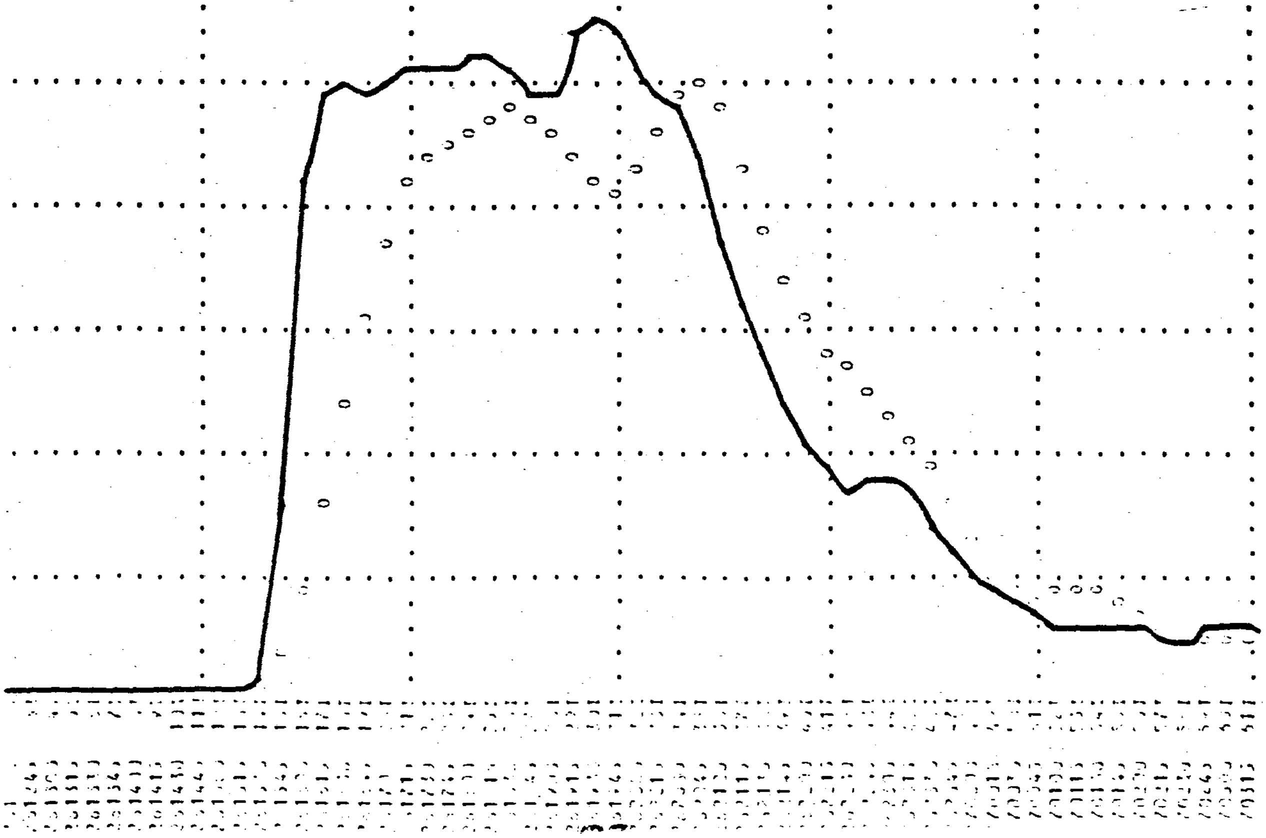
Compare with 35

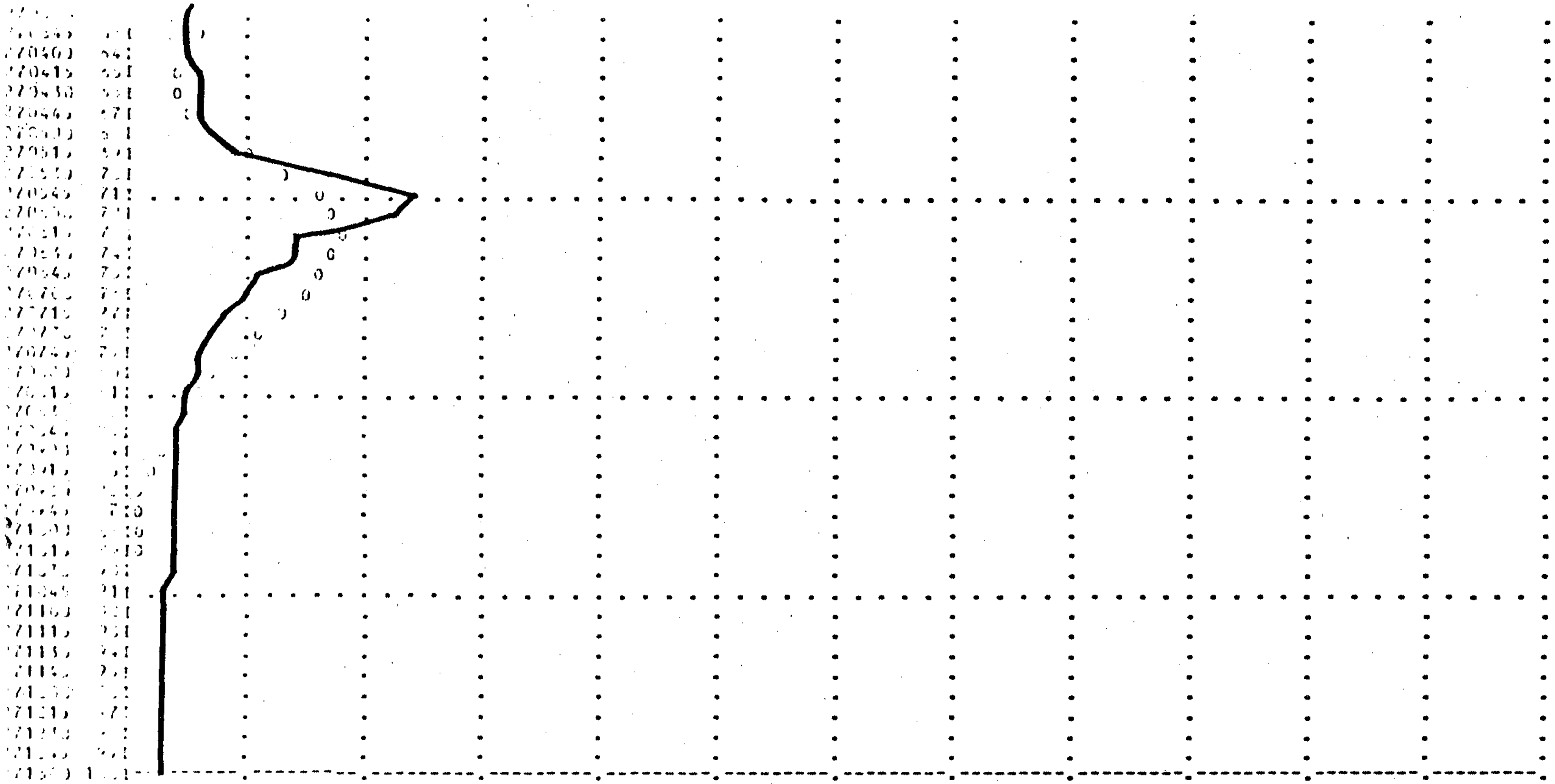
	Sum of flow	mean flow	Time to C.M.	peak flow	Time of peak
Computed	29917	299	9.70	1003	8.50
observed	32721	327	9.36	1099	7.25
diff	-2804	-28	0.34	-96	1.25
diff %	-8.57%			-8.74%	

Standard error: 148

Ave. abs. error: 90

Ave. % abs. error: 40.07%





RUN47 P2

```
                                   RUNOFF SUMMARY
                              FLOW IN CUBIC FEET PER SECOND
                           TIME IN HOURS,  AREA IN SQUARE MILES

                                PEAK   TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN     MAXIMUM     TIME OF
   OPERATION        STATION     FLOW     PEAK                                               AREA      STAGE     MAX STAGE
                                                  6-HOUR        24-HOUR      72-HOUR

HYDROGRAPH AT
                 [illegible]    596.    7.25        266.           78.          75.          2.98

ROUTED TO
                    1302        497.    7.75        264.           78.          75.          2.98

HYDROGRAPH AT
                 [illegible]    137.    3.50         77.           28.          27.          0.38

HYDROGRAPH AT
                 [illegible]      2.    0.25          0.            0.           0.          0.70
```

STORM #4 (Theissen) RON 48 P1

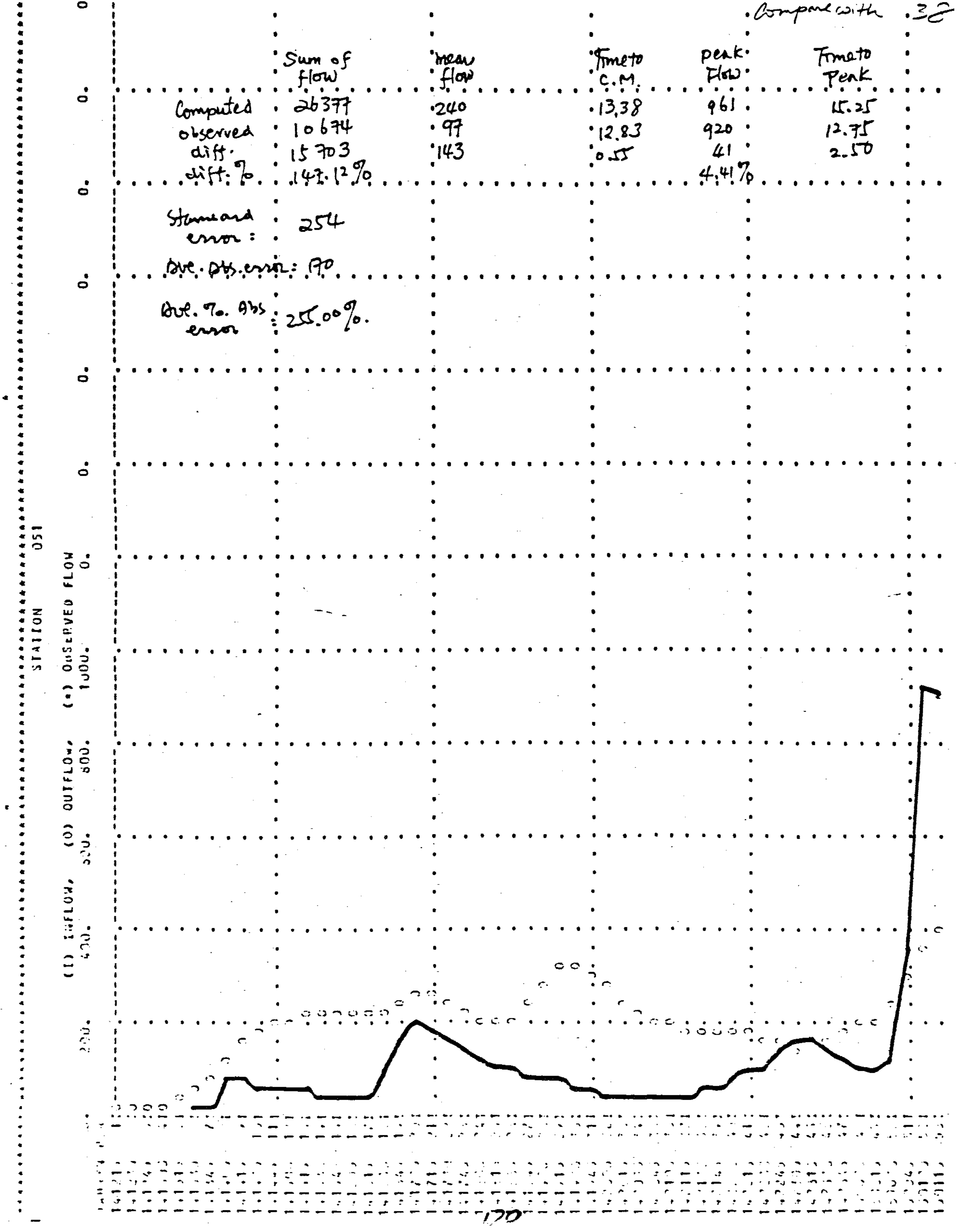
Compare with 38

	Sum of flow	mean flow	Time to C.M.	peak Flow	Time to Peak
Computed	26377	240	13,38	961	15.25
observed	10674	97	12.83	920	12.75
diff.	15703	143	0.55	41	2.50
diff. %	147.12%			4.41%	

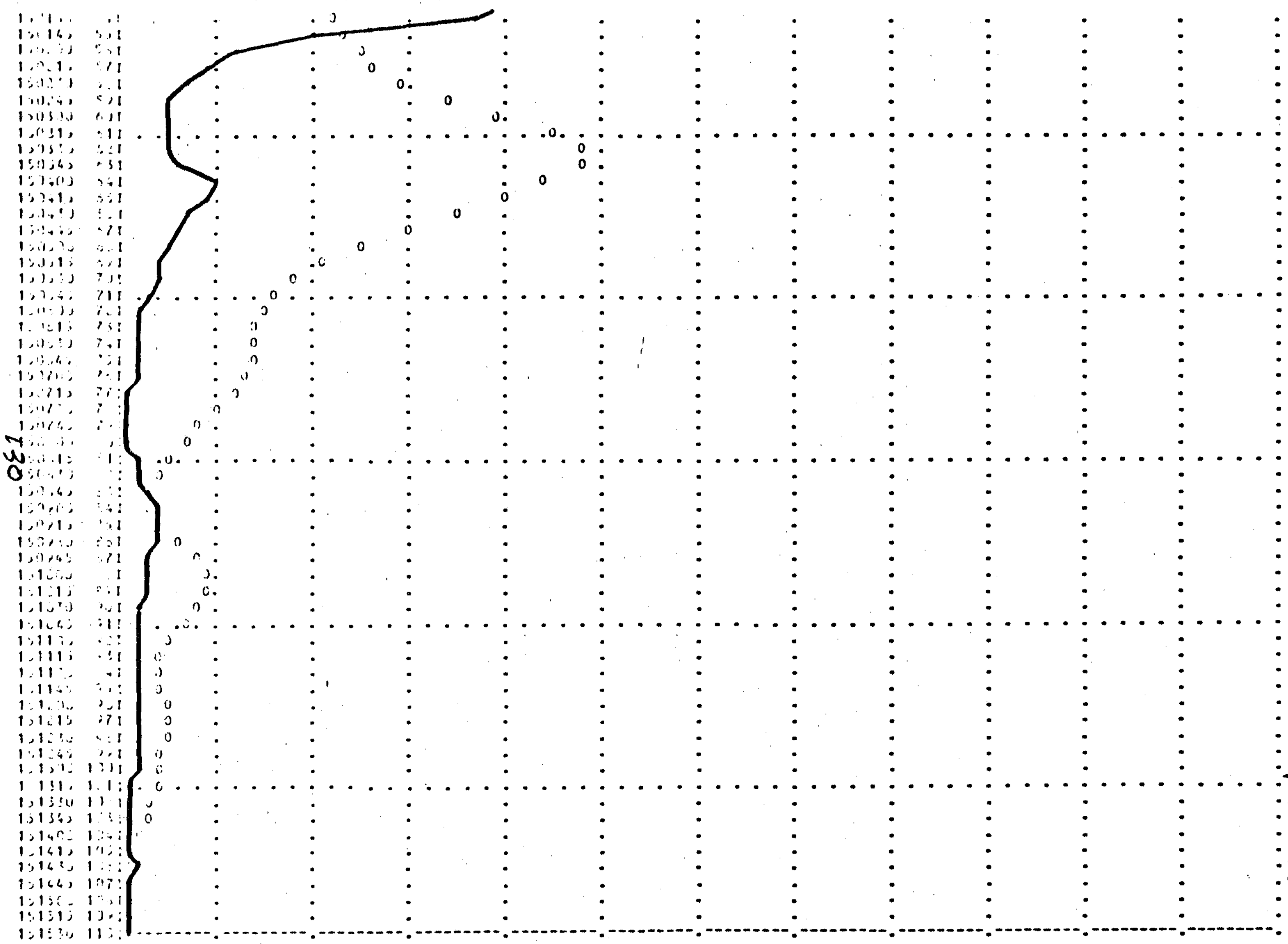
Standard error: 254

Ave. Abs. error: 170

Ave. %. Abs error: 255.00%.



RUN 48 P2

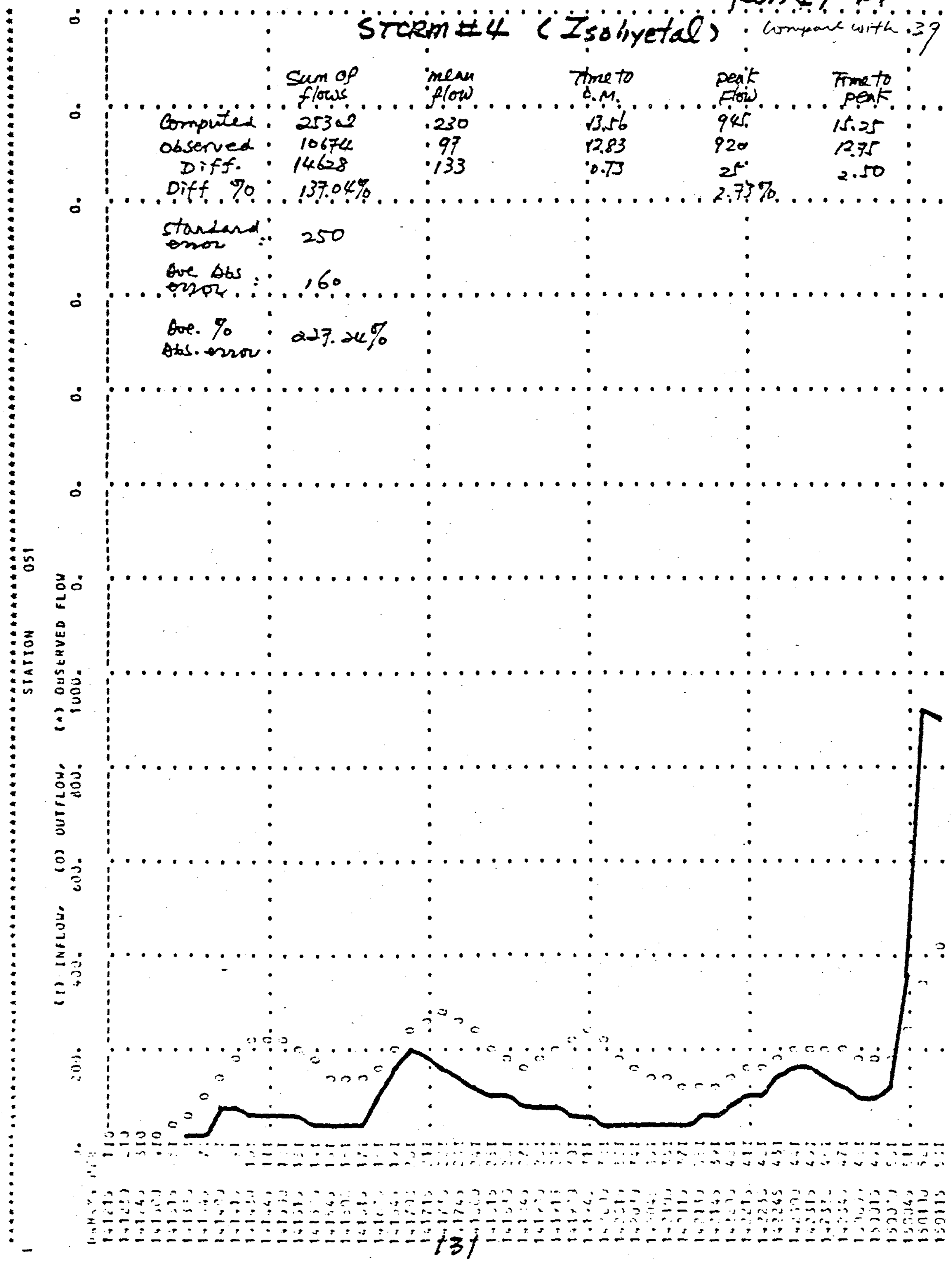


RUNOFF SUMMARY

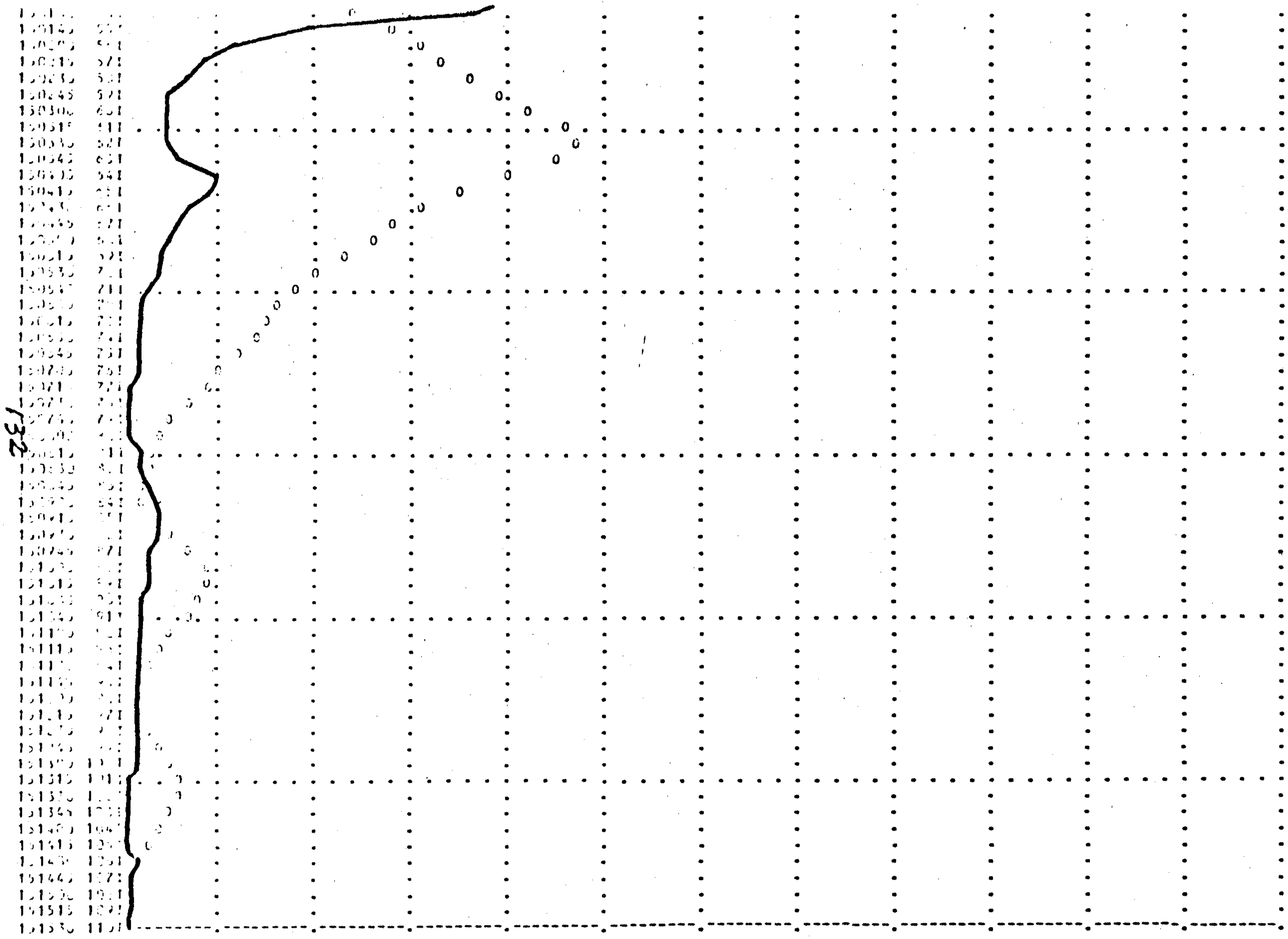
RUN 49 P1

STORM #4 (Isohyetal)

Compare with 39



	Sum of flows	mean flow	Time to C.M.	peak Flow	Time to peak
Computed	25302	.230	13.56	945	15.25
observed	10674	.97	12.83	920	12.75
Diff.	14628	.133	0.73	25	2.50
Diff %	137.04%			2.73%	
standard error	250				
ave Abs error	.160				
Ave. % Abs. error	227.24%				



RUNOFF SUMMARY

RUN 49 P2

RUN 50 P1

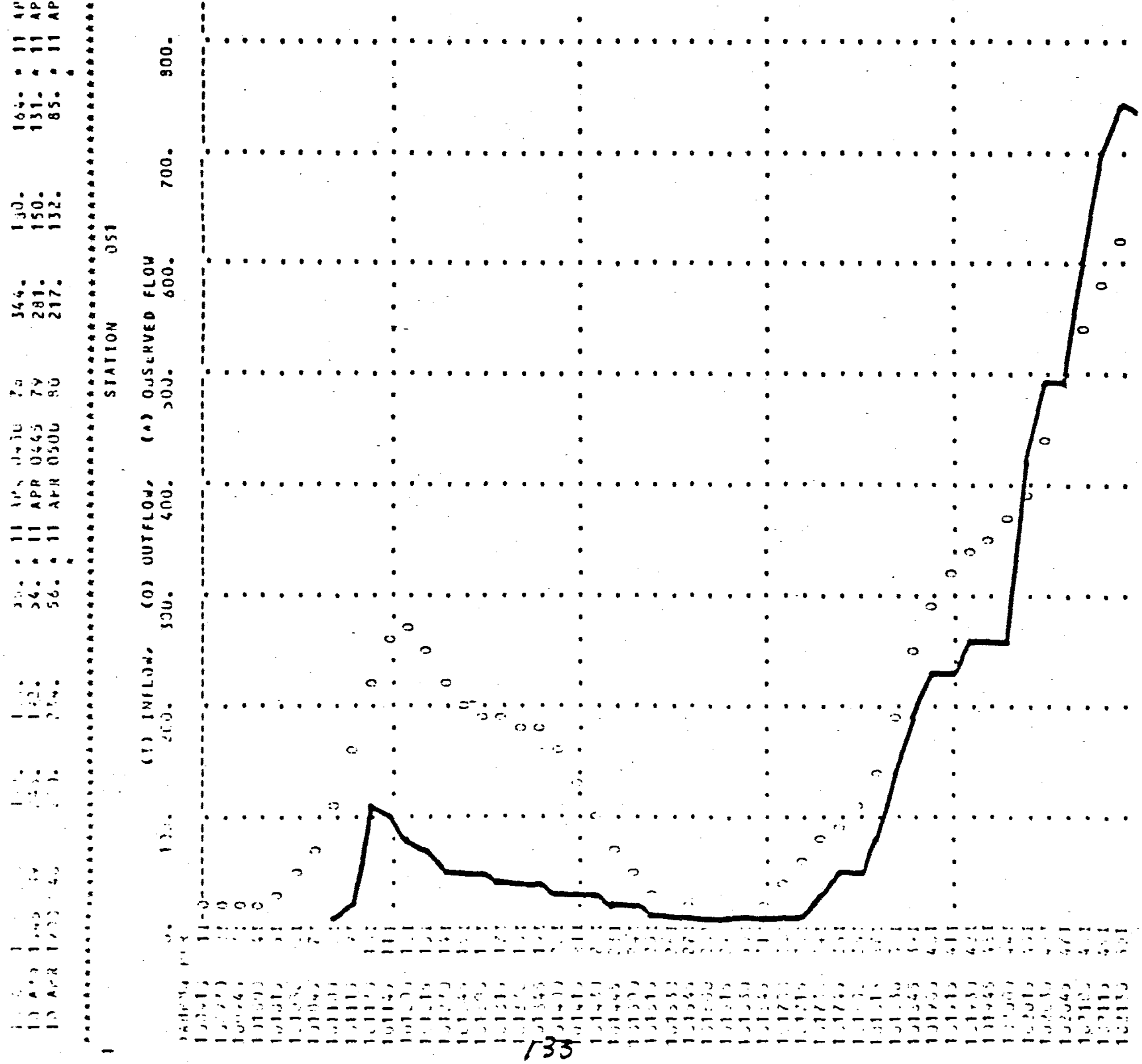
STORM #5 (Theissen)

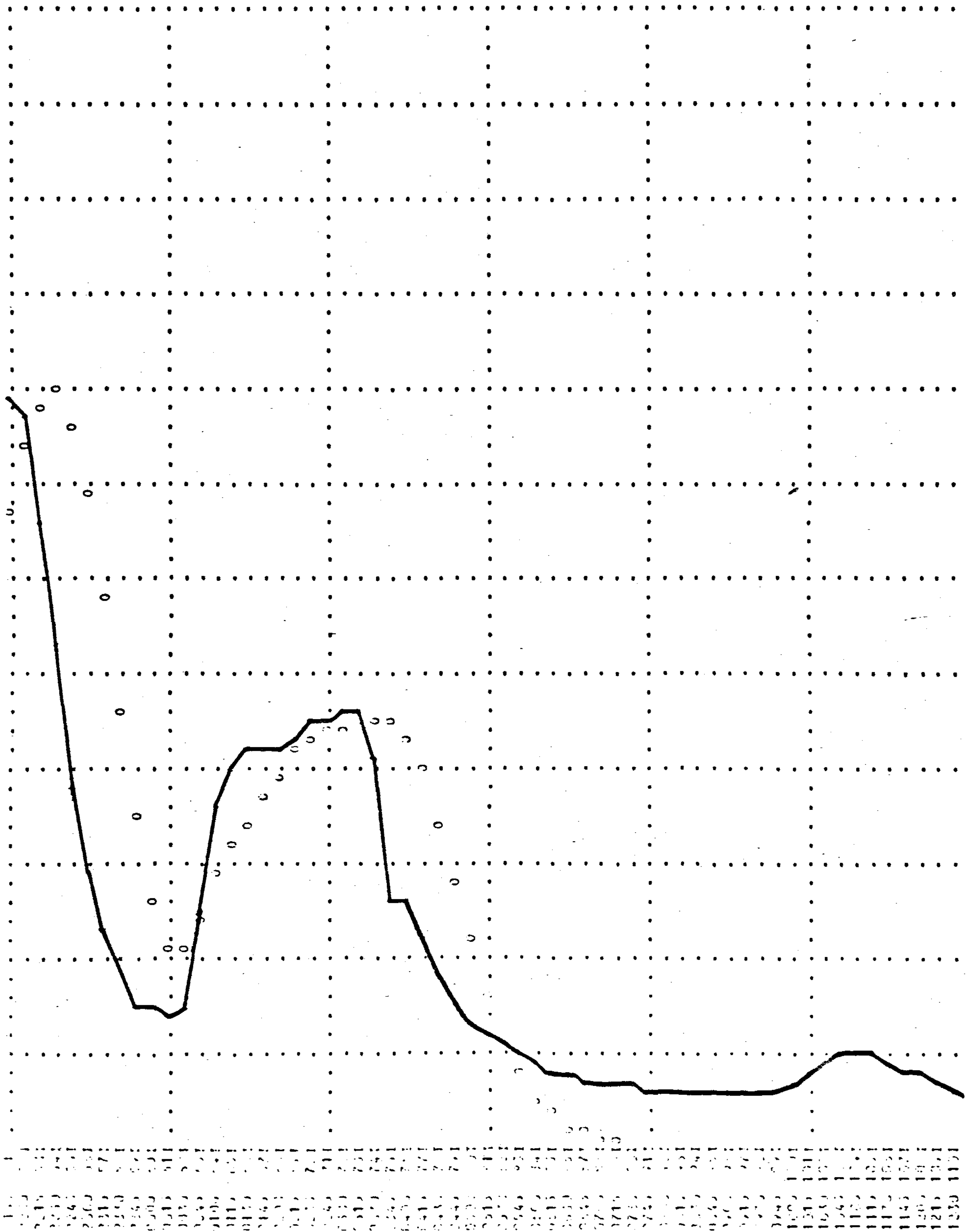
	Sum of flow	mean flow	Time to C.M.	peak Flow	Time to peak
Computed	22671	189	13.02	797	13.25
observed	19444	162	15.38	789	12.50
diff	3227	27	-2.36	8	0.75
diff %	16.60%			0.98%	

Standard Error : 107

Ave. Abs. Error: 81

Ave. % Abs Error = 195.52%





RUN 50 P2

RUN 51 P1

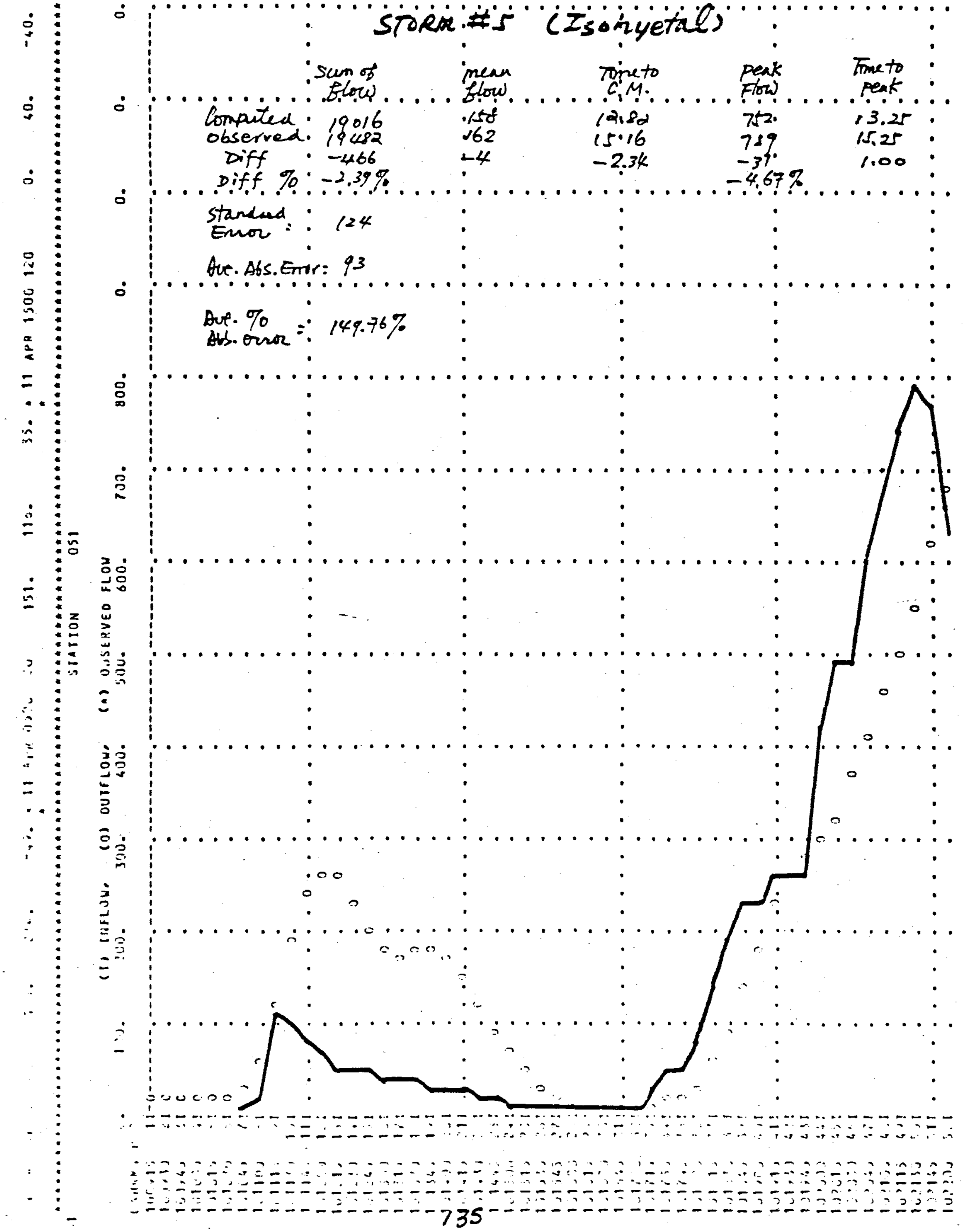
STORM #5 (Isohyetal)

	Sum of flow	mean flow	Time to C.M.	peak Flow	Time to peak
Computed	19016	158	12.82	752	13.25
observed	19482	162	15.16	789	15.25
Diff	-466	-4	-2.34	-37	1.00
Diff %	-2.39%			-4.67%	

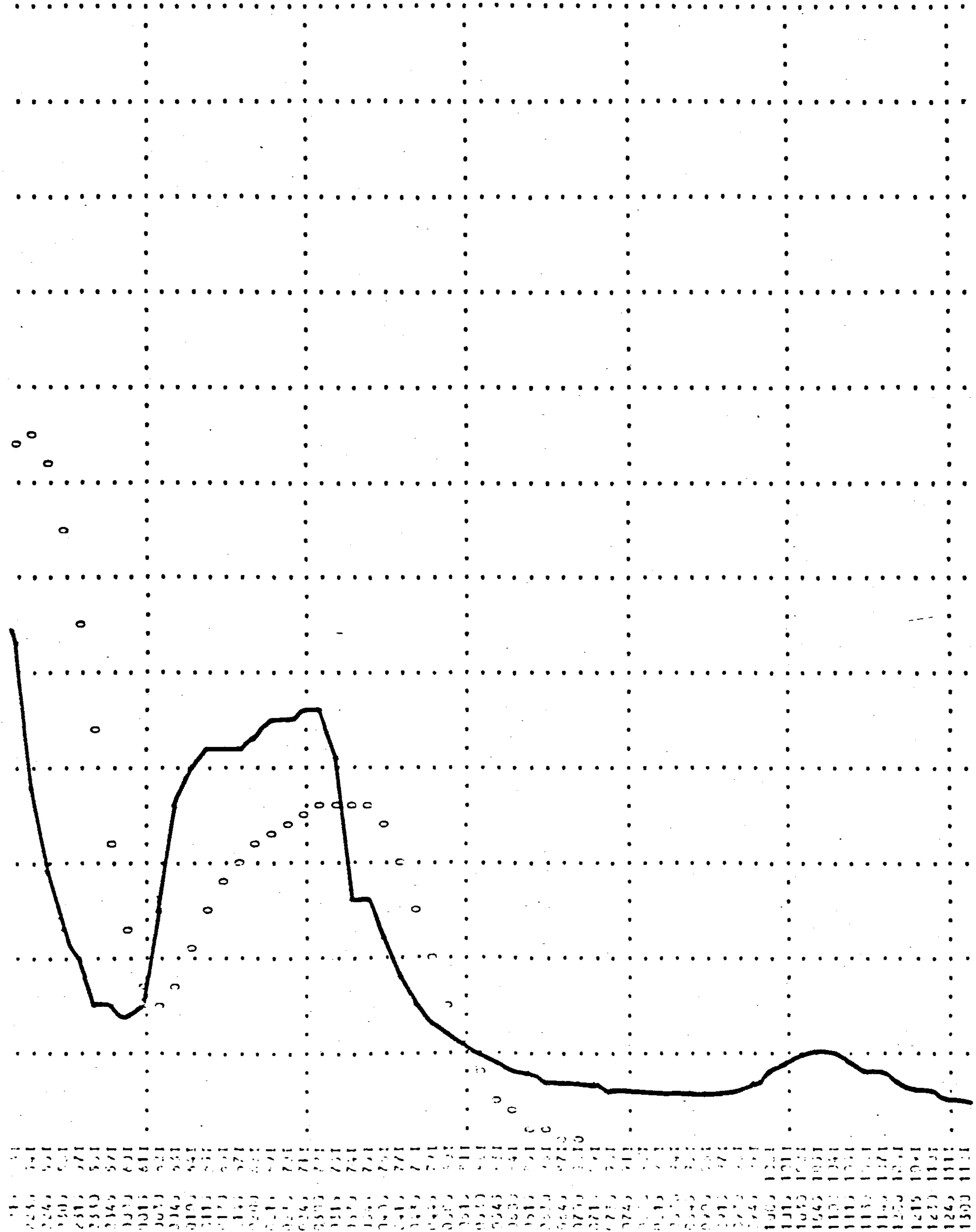
Standard Error: 124

Ave. Abs. Error: 93

Ave. % Abs. error = 149.76%



RON 51 P2

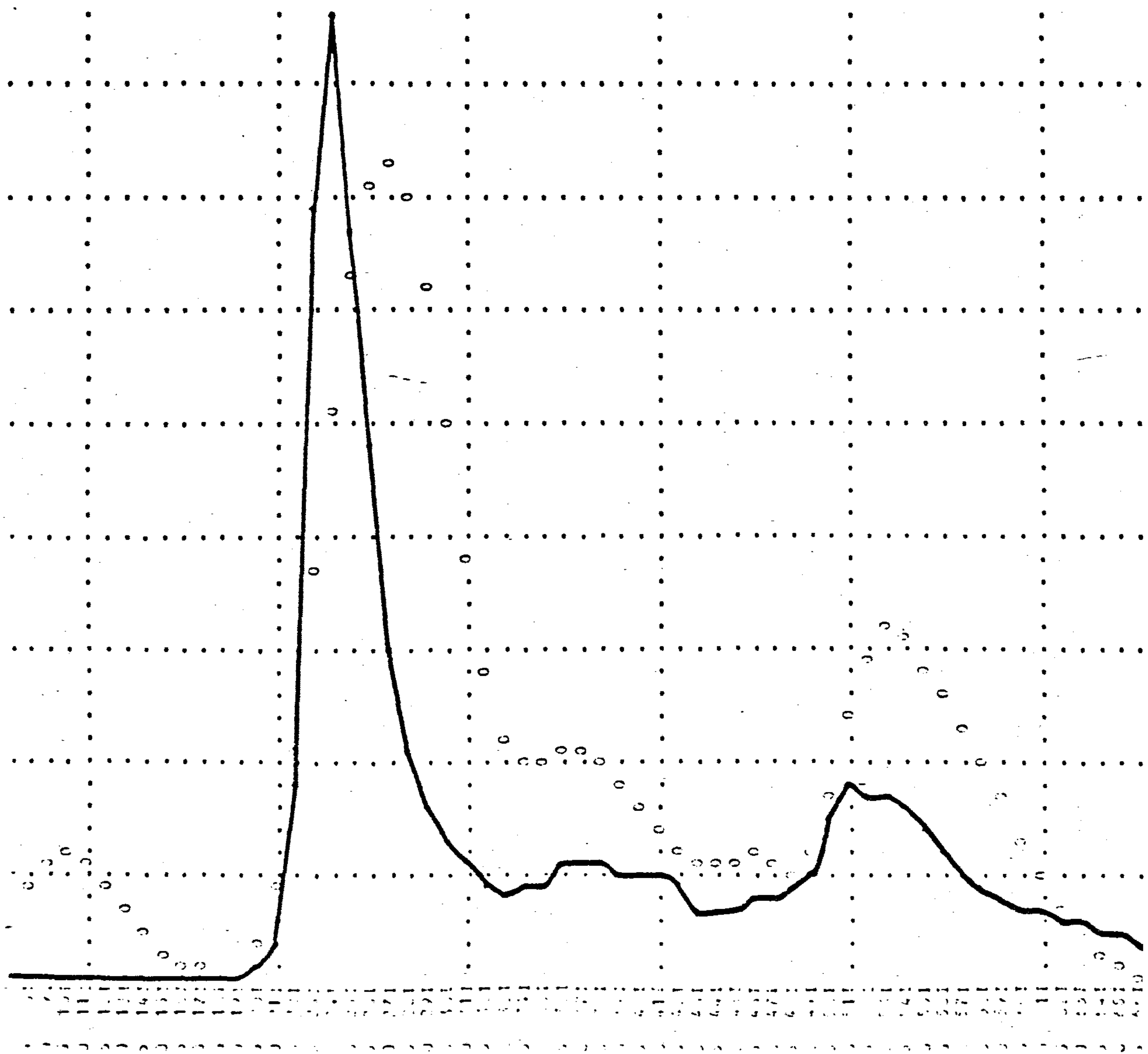


RON 52 P1

STORM #7 (Theissen).

	Sum of flow	mean flow	Time to C.M.	Peak flow	Time to peak
Computed	12255	170	8.79	734	6.50
observed	7682	107	9.03	862	5.75
diff	4573	64	-0.24	-128	.75
diff %	59.53%			-14.85%	

Standard error: 143
Ave. Abs. error: 91
Ave. % Abs. error: 142.45%



RUN S3 P1

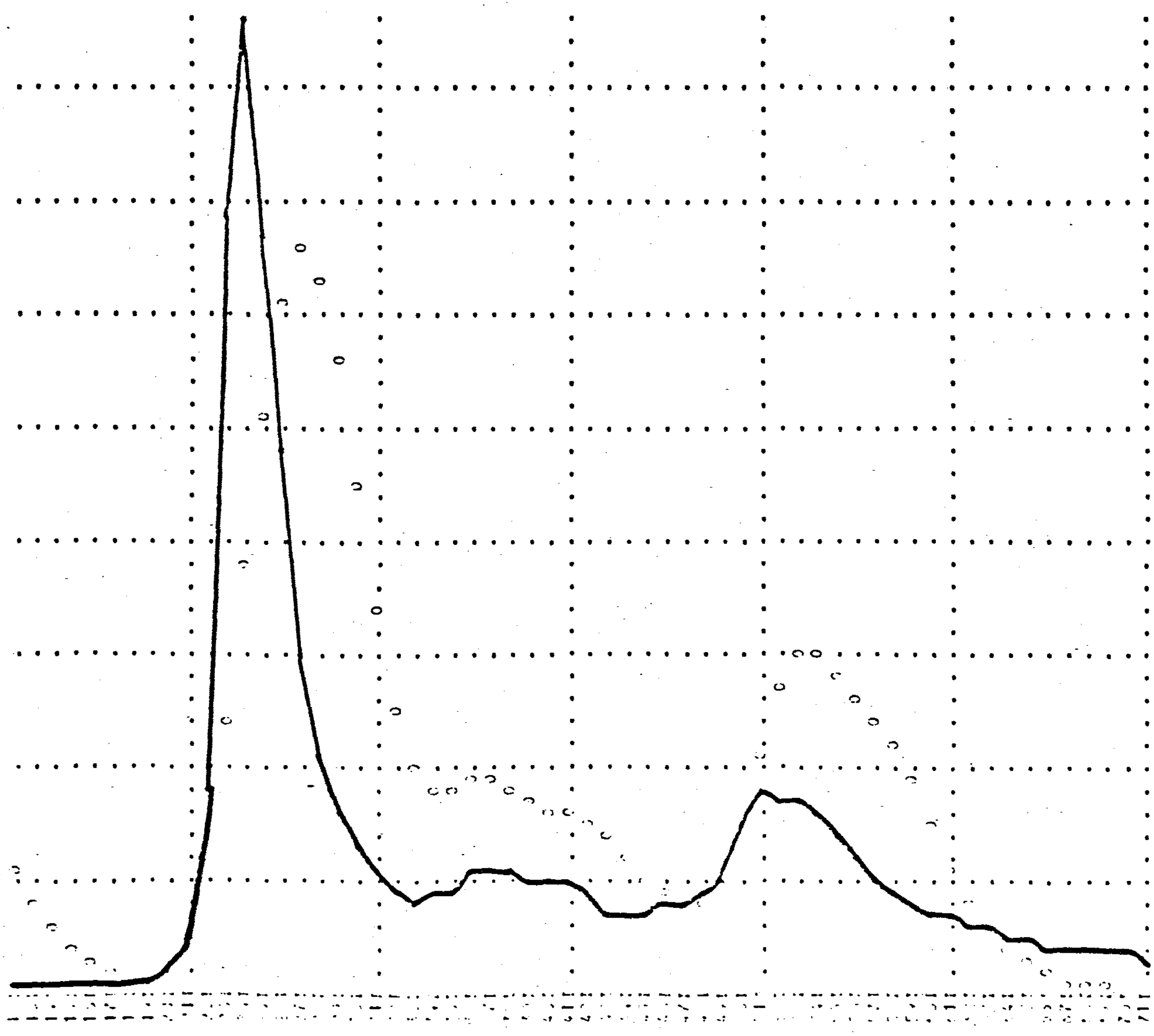
STORM #7 (Isohyetal)

	sum of flow	mean flow	Time to C.M.	mean flow	Time to peak
Computed	11175	155	9.00	656	6.50
observed	7682	107	9.03	862	5.75
diff.	3493	49		-206	.75
diff %	45.46%		-0.03	-23.91	

Standard Error: 140

Ave. Abs. Error: 88

Ave % Abs Error: 138.57%



```
*   [illegible] HYDROGRAPH         27371.      1.953          342.      7.25        7.25        1149.      6.75     *
*                                                                                                                   *
*   DIFFERENCE                      1972.      0.079           25.      0.42        0.42          20.      1.50     *
*   PERCENT DIFFERENCE              7.20                                            5.77          1.73              *
*                                                                                                                   *
*                   STANDARD ERROR       250.            AVERAGE ABSOLUTE ERROR        166.                         *
*               OBJECTIVE FUNCTION       271.      AVERAGE PERCENT ABSOLUTE ERROR    61.11                          *
*                                                                                                                   *
*********************************************************************************************************************

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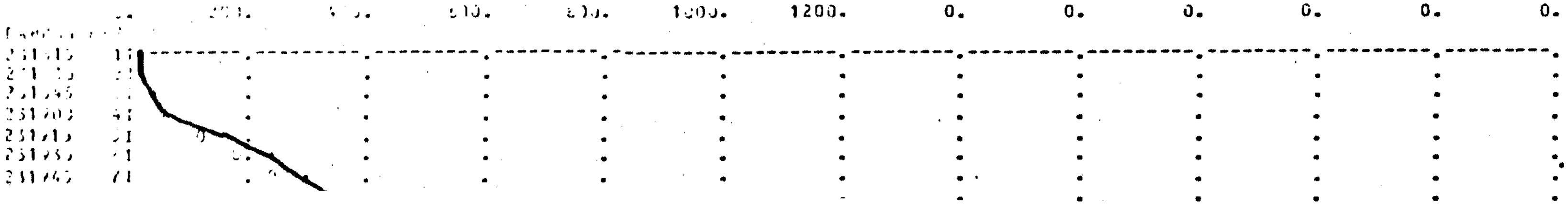
                                       HYDROGRAPH AT STATION      051

*************************************************************************************************************************
                                                   *                                                     *
DA MON HRMN ORD      COMP Q      OBS Q   RESIDUL  * DA MON HRMN ORD     COMP Q     OBS Q   RESIDUL  * DA MON HRMN ORD     COMP Q     OBS Q   RESIDUL
                                                   *                                                     *
23 JAN 1815   1         71.        72.       -1.  * 24 JAN 0100  28       860.     1149.     -289.  * 24 JAN 0745  55       104.      107.       -3.
23 JAN 1830   2         71.        72.       -1.  * 24 JAN 0115  29       902.     1134.     -232.  * 24 JAN 0800  56       132.      107.       25.
23 JAN 1845   3         71.        72.       -1.  * 24 JAN 0130  30       955.     1067.     -112.  * 24 JAN 0815  57       149.      102.       47.
23 JAN 1900   4         61.        57.        4.  * 24 JAN 0145  31      1026.      964.       62.  * 24 JAN 0830  58       146.       90.       56.
23 JAN 1915   5        111.       150.      -39.  * 24 JAN 0200  32      1105.      772.      333.  * 24 JAN 0845  59       127.       90.       37.
23 JAN 1930   6        176.       234.      -58.  * 24 JAN 0215  33      1164.      608.      556.  * 24 JAN 0900  60       101.       81.       20.
23 JAN 1945   7        243.       299.      -56.  * 24 JAN 0230  34      1169.      469.      700.  * 24 JAN 0915  61        74.       81.       -7.
23 JAN 2000   8        323.       375.      -52.  * 24 JAN 0245  35      1113.      365.      748.  * 24 JAN 0930  62        53.       77.      -24.
23 JAN 2015   9        353.       359.       -6.  * 24 JAN 0300  36      1018.      301.      717.  * 24 JAN 0945  63        36.       67.      -31.
23 JAN 2030  10        394.       352.       42.  * 24 JAN 0315  37       915.      301.      614.  * 24 JAN 1000  64        25.       67.      -42.
23 JAN 2045  11        404.       349.       55.  * 24 JAN 0330  38       825.      460.      365.  * 24 JAN 1015  65        17.       67.      -50.
23 JAN 2100  12        442.       405.       37.  * 24 JAN 0345  39       754.      567.      187.  * 24 JAN 1030  66        11.       65.      -54.
23 JAN 2115  13        455.       414.       41.  * 24 JAN 0400  40       705.      538.      167.  * 24 JAN 1045  67         7.       61.      -54.
23 JAN 2130  14        405.       374.       31.  * 24 JAN 0415  41       677.      458.      219.  * 24 JAN 1100  68         5.       59.      -54.
23 JAN 2145  15        472.       331.      141.  * 24 JAN 0430  42       663.      365.      298.  * 24 JAN 1115  69         3.       59.      -56.
23 JAN 2200  16        468.       313.      155.  * 24 JAN 0445  43       643.      299.      344.  * 24 JAN 1130  70         2.       59.      -57.
23 JAN 2215  17  [illegible] [illegible]     67.  * 24 JAN 0500  44       608.      245.      363.  * 24 JAN 1145  71         1.       57.      -56.
23 JAN 2230  18  [illegible] [illegible]   -179.  * 24 JAN 0515  45       551.      202.      349.  * 24 JAN 1200  72         1.       55.      -54.
23 JAN 2245  19  [illegible]      797.     -357.  * 24 JAN 0530  46       480.      175.      305.  * 24 JAN 1215  73         1.       55.      -54.
23 JAN 2300  20  [illegible]      713.     -453.  * 24 JAN 0545  47       394.      151.      243.  * 24 JAN 1230  74         0.       51.      -51.
23 JAN 2315  21  [illegible]      995.     -492.  * 24 JAN 0600  48       295.      136.      159.  * 24 JAN 1245  75         0.       51.      -51.
23 JAN 2330  22  [illegible]     1034.     -474.  * 24 JAN 0615  49       202.      116.       86.  * 24 JAN 1300  76         0.       51.      -51.
23 JAN 2345  23  [illegible]     1375.     -445.  * 24 JAN 0630  50       133.      116.       17.  * 24 JAN 1315  77         0.       49.      -49.
24 JAN 0000  24  [illegible]     1324.     -539.  * 24 JAN 0645  51        89.      108.      -19.  * 24 JAN 1330  78         0.       49.      -49.
24 JAN 0015  25        777.      1372.     -595.  * 24 JAN 0700  52        65.      101.      -36.  * 24 JAN 1345  79         0.       46.      -46.
24 JAN 0030  26  [illegible]     1393.     -510.  * 24 JAN 0715  53        62.       99.      -37.  * 24 JAN 1400  80         0.       40.      -40.
24 JAN 0045  27  [illegible]     1117.     -304.  * 24 JAN 0730  54        78.       99.      -21.  *
                                                   *                                                     *
*************************************************************************************************************************
1                                                        STATION      051

                              (I) INFLOW,   (O) OUTFLOW,   (*) OBSERVED FLOW
```



189

Run Sup.

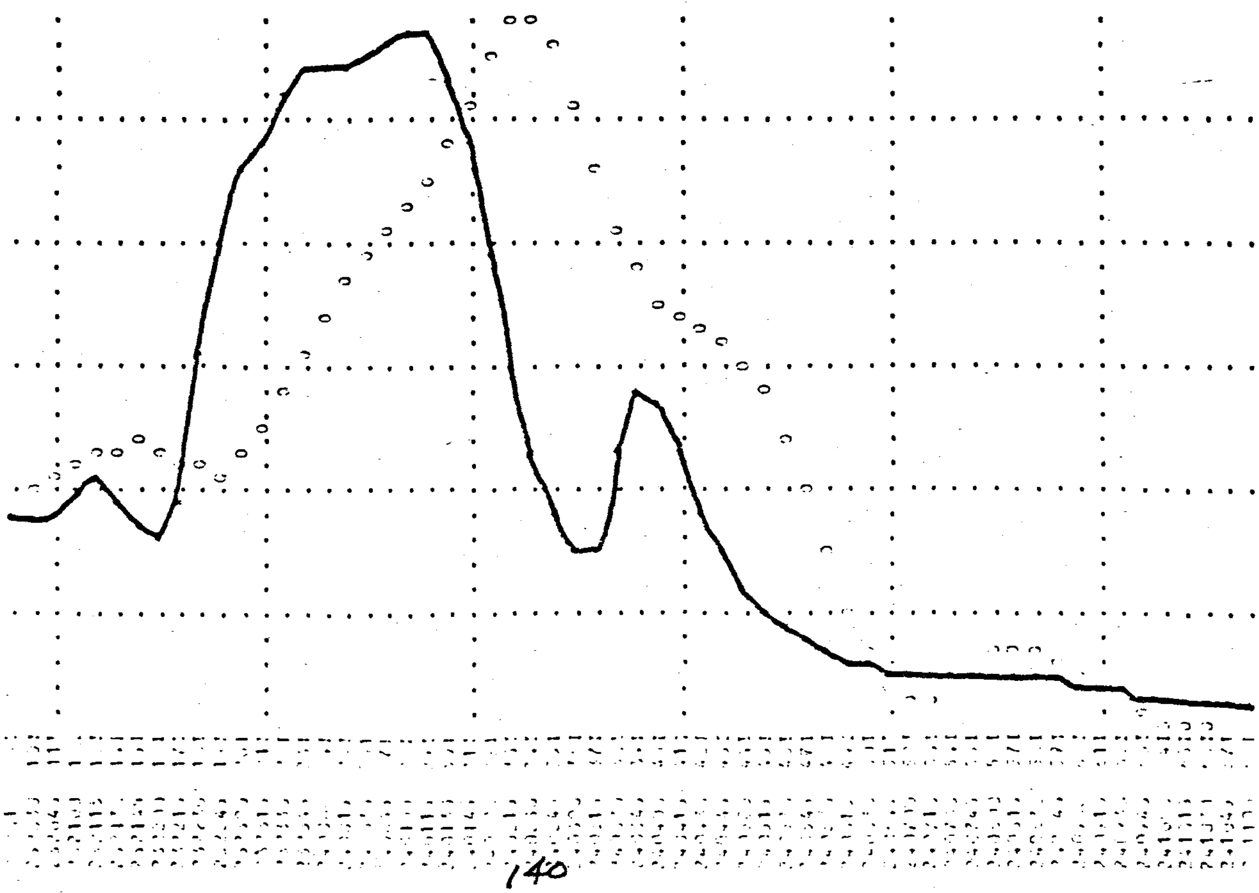
STORM #1 (THIESSEN) RUN 57 P2

* RECONSTITUTION AGAIN.
USE STORM dependent DLTKR; (Run 54 ~ Run 63)
with Fixed Loss Rate. A: 60%
B, H: 55%
I, J, L, M, N: 45%

	sum of flows	mean flow	Time to C.M.	peak Flow	Time to peak
Computed	29362	367	7.66	1169	8.25
observed	27370	342	7.25	1149	6.75
Diff	1992	25	0.41	20	1.50
Diff %	7.28%			1.73%	

Standard Error: 250
Ave. Abs. Error: 166
Ave. % Abs Error: 61.11%

DLTKR:
A 1.4 → 2.0.
Bp 1.6 → 1.17
Hp 1.6 → 1.10
Ip 1.2 → 0.88
Jp → 0.88
Lp 1.0 → 0.95
Mp 1.0 → 0.95
Np 1.0 → 0.95



```
 .  [illegible]                 [illegible]     1.0?5          342.      7.25      7.25      1149.      6.75    .
 .                                                                                                           .
 .  DIFFERENCE                 -1577.    -0.063          -20.      0.03      0.03        76.      1.25    .
 .  PERCENT DIFFERENCE          -5.70                                        0.38       6.63              .
 .                                                                                                           .
 .                 STANDARD ERROR      221.                 AVERAGE ABSOLUTE ERROR      130.                .
 .              OBJECTIVE FUNCTION     267.         AVERAGE PERCENT ABSOLUTE ERROR     49.28               .
 .                                                                                                           .
 .............................................................................................................

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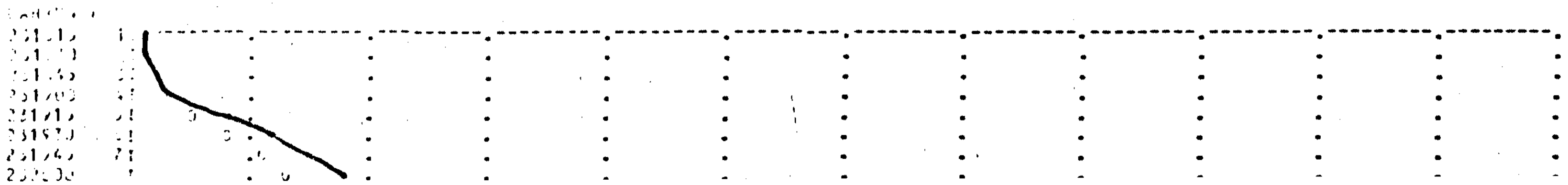
                                        HYDROGRAPH AT STATION      051

.........................................................................................................................
                                                    .                                                 .
 DA MON HRMN ORD    COMP Q      OBS Q    RESIDUL    .  DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL   .  DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL
                                                    .                                                 .
 23 JAN 1815   1       1.  [illegible]       -1.    .  24 JAN 0100  28     955.     1149.     -193.   .  24 JAN 0745  55       70.      107.      -37.
 23 JAN 1830   2 [illegible] [illegible]     -1.    .  24 JAN 0115  29    1024.     1134.     -110.   .  24 JAN 0800  56       96.      107.      -11.
 23 JAN 1845   3 [illegible] [illegible]     -4.    .  24 JAN 0130  30    1089.     1067.       22.   .  24 JAN 0815  57      113.      102.       11.
 23 JAN 1900   4 [illegible]      57.        -5.    .  24 JAN 0145  31    1150.      964.      186.   .  24 JAN 0830  58      115.       90.       25.
 23 JAN 1915   5 [illegible] [illegible]    -55.    .  24 JAN 0200  32    1203.      772.      431.   .  24 JAN 0845  59      103.       90.       13.
 23 JAN 1930   6 [illegible] [illegible] [illegible] . 24 JAN 0215  33    1223.      606.      617.   .  24 JAN 0900  60       83.       81.        2.
 23 JAN 1945   7 [illegible] [illegible] [illegible] . 24 JAN 0230  34    1184.      469.      715.   .  24 JAN 0915  61       62.       81.      -19.
 23 JAN 2000   8 [illegible] [illegible] [illegible] . 24 JAN 0245  35    1071.      365.      706.   .  24 JAN 0930  62       44.       77.      -33.
 23 JAN 2015   9     317. [illegible] [illegible]  .  24 JAN 0300  36     917.      301.      616.   .  24 JAN 0945  63       31.       67.      -36.
 23 JAN 2030  10 [illegible] [illegible]      3.    .  24 JAN 0315  37     764.      301.      463.   .  24 JAN 1000  64       21.       67.      -46.
 23 JAN 2045  11 [illegible] [illegible]     14.    .  24 JAN 0330  38     639.      460.      179.   .  24 JAN 1015  65       14.       67.      -53.
 23 JAN 2100  12 [illegible] [illegible]     -2.    .  24 JAN 0345  39     548.      567.      -19.   .  24 JAN 1030  66        9.       65.      -56.
 23 JAN 2115  13 [illegible]     414.         0.    .  24 JAN 0400  40     434.      533.      -54.   .  24 JAN 1045  67        6.       61.      -55.
 23 JAN 2130  14     417. [illegible]        33.    .  24 JAN 0415  41     438.      458.      -20.   .  24 JAN 1100  68        4.       59.      -55.
 23 JAN 2145  15 [illegible]     371.        34.    .  24 JAN 0430  42     402.      365.       37.   .  24 JAN 1115  69        3.       59.      -56.
 23 JAN 2200  16 [illegible] [illegible] [illegible] . 24 JAN 0445  43     360.      299.       61.   .  24 JAN 1130  70        2.       59.      -57.
 23 JAN 2215  17 [illegible] [illegible]      4.    .  24 JAN 0500  44     309.      245.       64.   .  24 JAN 1145  71        1.       57.      -56.
 23 JAN 2230  18 [illegible] [illegible] [illegible] . 24 JAN 0515  45     243.      202.       41.   .  24 JAN 1200  72        1.       55.      -54.
 23 JAN 2245  19 [illegible]     797. [illegible]  .  24 JAN 0530  46     178.      175.        3.   .  24 JAN 1215  73        0.       55.      -55.
 23 JAN 2300  20 [illegible] [illegible] [illegible] . 24 JAN 0545  47     125.      151.      -26.   .  24 JAN 1230  74        0.       51.      -51.
 23 JAN 2315  21 [illegible] [illegible] [illegible] . 24 JAN 0600  48      86.      136.      -50.   .  24 JAN 1245  75        0.       51.      -51.
 23 JAN 2330  22 [illegible] [illegible] [illegible] . 24 JAN 0615  49      58.      116.      -58.   .  24 JAN 1300  76        0.       51.      -51.
 23 JAN 2345  23 [illegible] [illegible] [illegible] . 24 JAN 0630  50      39.      116.      -77.   .  24 JAN 1315  77        0.       49.      -49.
 24 JAN 0000  24 [illegible] [illegible] [illegible] . 24 JAN 0645  51      26.      108.      -82.   .  24 JAN 1330  78        0.       49.      -49.
 24 JAN 0015  25 [illegible] [illegible] [illegible] . 24 JAN 0700  52      22.      101.      -79.   .  24 JAN 1345  79        0.       46.      -46.
 24 JAN 0030  26 [illegible] [illegible] [illegible] . 24 JAN 0715  53      30.       99.      -69.   .  24 JAN 1400  80        0.       40.      -40.
 24 JAN 0045  27 [illegible]    11?7.      -237.    .  24 JAN 0730  54      47.       99.      -52.   .
                                                    .                                                 .
.........................................................................................................................
                                                   STATION      051

                   (I) INFLOW,   (O) OUTFLOW,   (*) OBSERVED FLOW
          .      200.      400.      600.      800.     1000.     1200.     1400.      0.       0.       0.       0.       0.
```



141

Run 57 P1

Run 55 P2

STORM #1 (Z50 HYETAL)

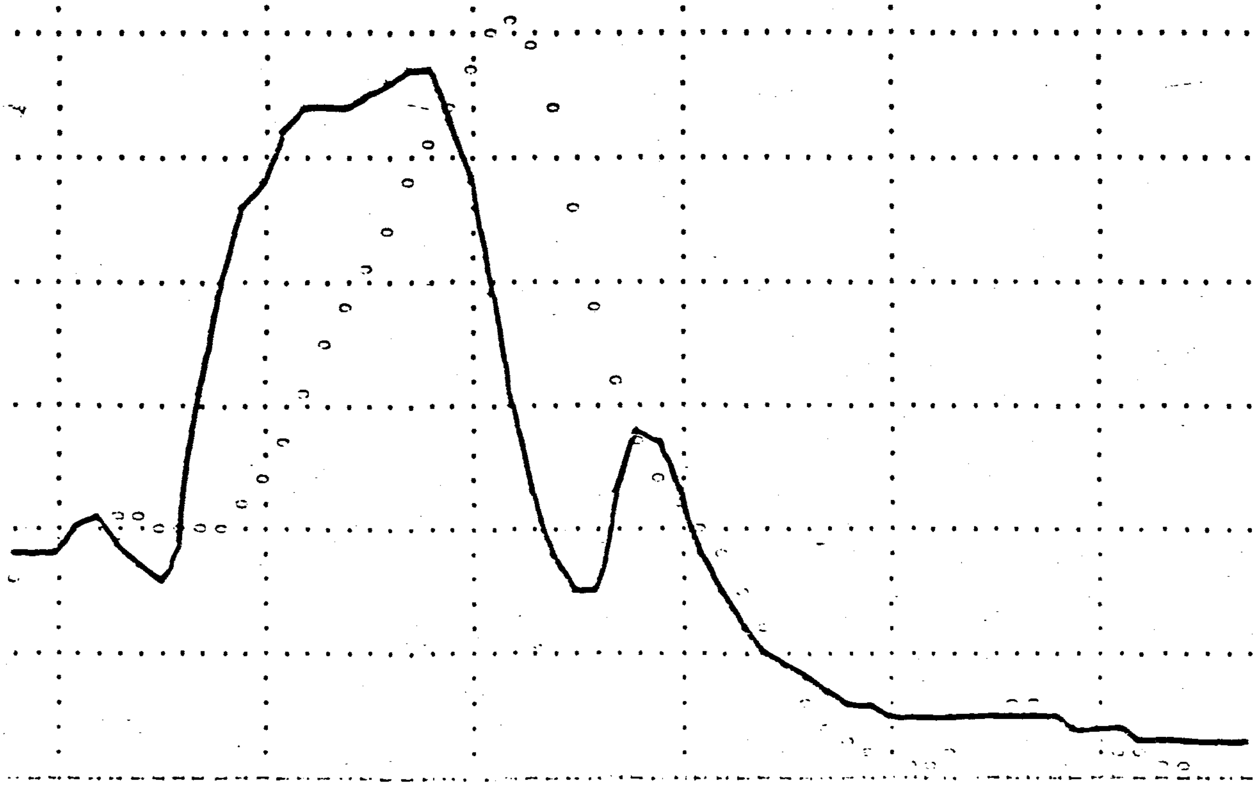
	Sum of Flows	mean Flow	Time to C.M.	peak Flow	Time to peak
Computed	25793	322	7.27	1225	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	-1577	-20	0.03	76	1.25
Diff. %	-5.76%			6.63%	

Standard Error: 221

Ave. Abs. Error: 130

Ave. Abs. % Error: 49.28%

DLTKR:
A → 1.84
Bp → 1.41
Hp → 1.76
Ip → 0.99
Jp → 1.27
Lp → 0.93
Mp → 1.04
Np → 0.93



STORM #2 Run 56. P1

(THEISSEN)

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to peak
Computed	35078	351	10.11	1129	8.50
Observed	32721	327	9.36	1099	7.25
Diff.	2357	24	0.75	30	1.25
Diff %	7.20%		8.06%	2.73%	

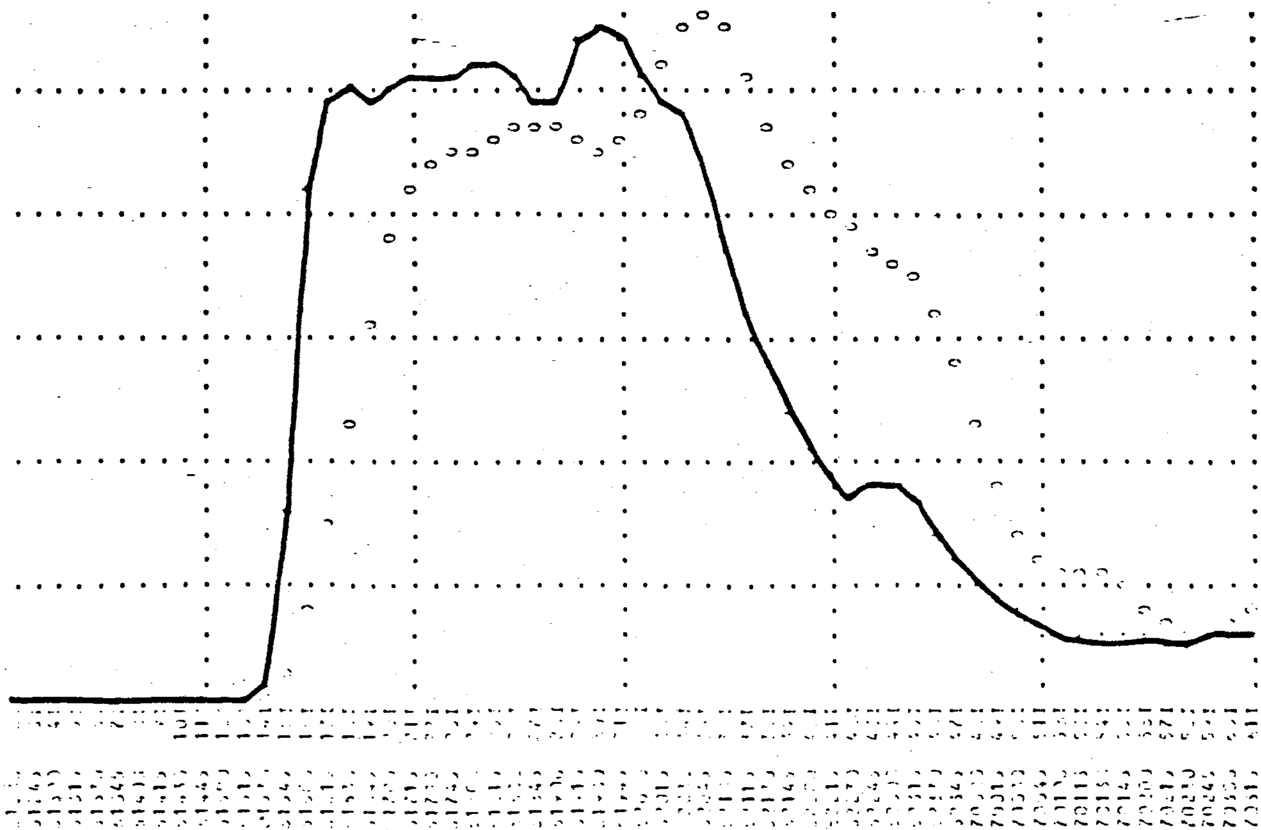
Standard Error: 198

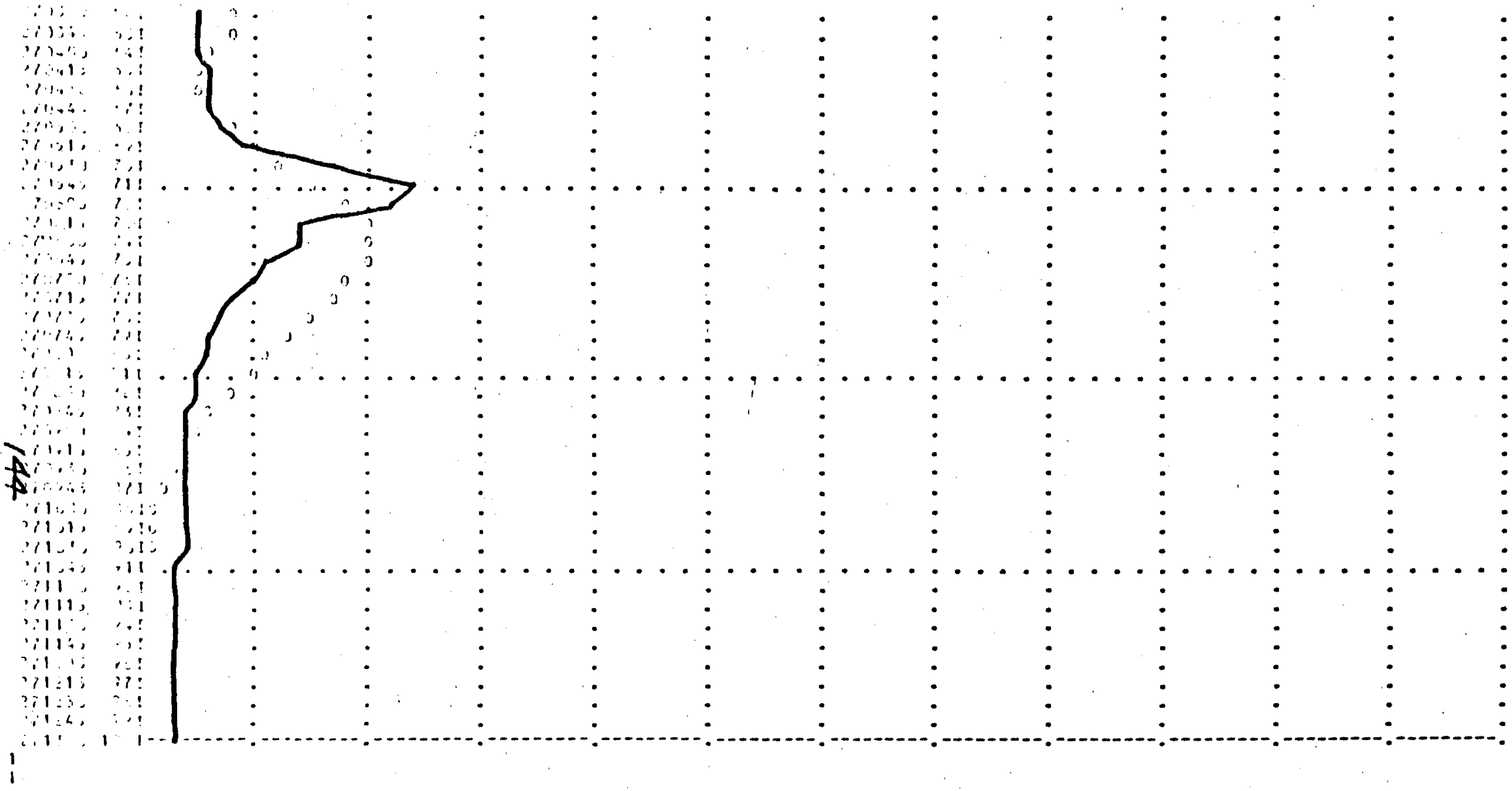
Ave. Abs. Error: 132

Ave % Abs Error: 56.71%

DCTKR.

A → 2.06
Bp → 1.42
Hp → 1.31
Ip → 1.10
Jp → 1.10
Lp → 1.10
Mp → 1.08
Np → 1.10.





144

Run 56. P2

```
                                        RUNOFF SUMMARY
                                  FLOW IN CUBIC FEET PER SECOND
                               TIME IN HOURS,  AREA IN SQUARE MILES

                                PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM    TIME OF
   OPERATION        STATION     FLOW    PEAK                                            AREA      STAGE   MAX STAGE
                                                  6-HOUR      24-HOUR       72-HOUR

   HYDROGRAPH AT
                       05A      566.    7.25        251.          89.           86.      2.98

   ROUTED TO
                      170.      430.    7.75        249.          89.           86.      2.98

   HYDROGRAPH AT
                       60S      152.    3.50         90.          31.           30.      0.38

   HYDROGRAPH AT
                        10       21.    7.00          4.           1.            1.      0.70
```

Run 57 P1

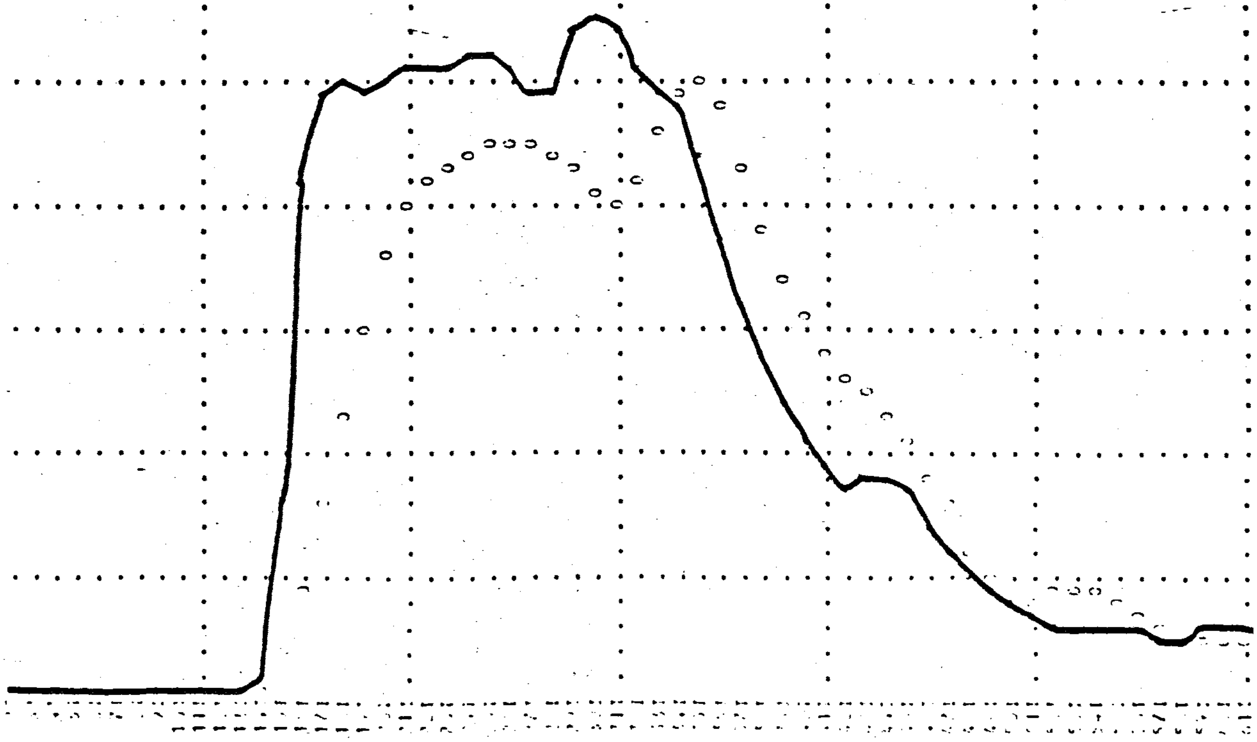
STORM # 2 (ZSO HYETAL)

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to Peak
Computed	29334	293	9.73	1001	8.50
observed	32721	327	9.36	1099	7.25
Diff.	-3387	-34	0.38	-98	1.25
Diff. %	-10.35%		4.02%	-8.95%	

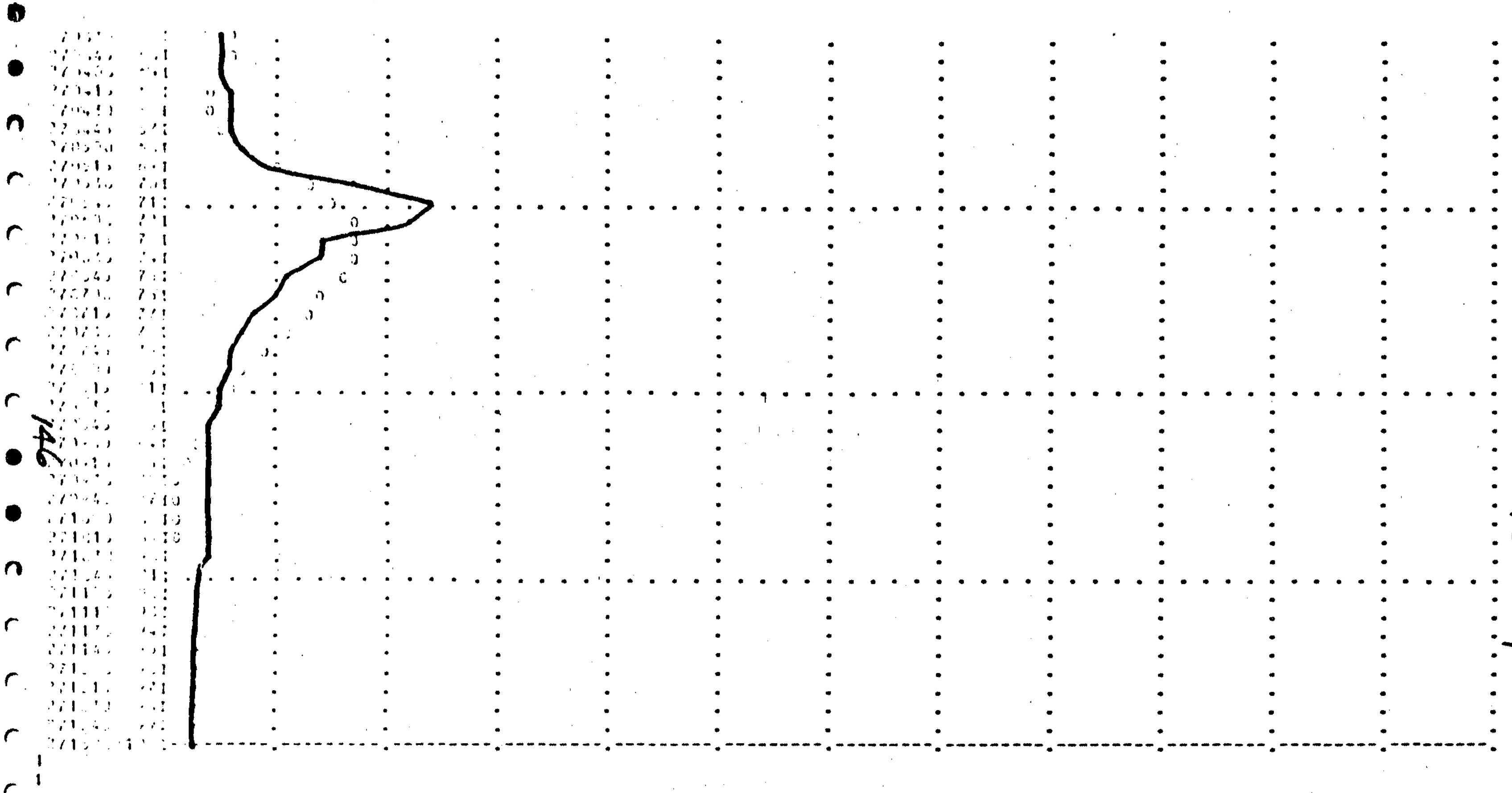
Standard Error: 152
Ave. Abs. Error: 94
Ave. % Abs. Error: 40.26%

DLTKR:

A → 1.93
Bp → 1.60
Hp → 1.82
Ip → 1.42
Jp → 1.36
Lp → 1.10
Mp → 1.21
Np → 1.10



Run 57 P2.



```
                                      RUNOFF SUMMARY
                               FLOW IN CUBIC FEET PER SECOND
                           TIME IN HOURS, AREA IN SQUARE MILES

                              PEAK   TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM    TIME OF
   OPERATION      STATION     FLOW     PEAK                                          AREA     STAGE     MAX STAGE
                                               6-HOUR       24-HOUR       72-HOUR

   HYDROGRAPH AT
                  [illegible]  595.     7.25     247.          73.           71.       2.93

   [illegible]
                   1102        495.     7.75     245.          73.           71.       2.98

   [illegible]
                  [illegible]  137.     3.50      77.          28.           27.       0.38

   HYDROGRAPH AT
                  [illegible]    2.     0.25       0.           0.            0.       0.70
```

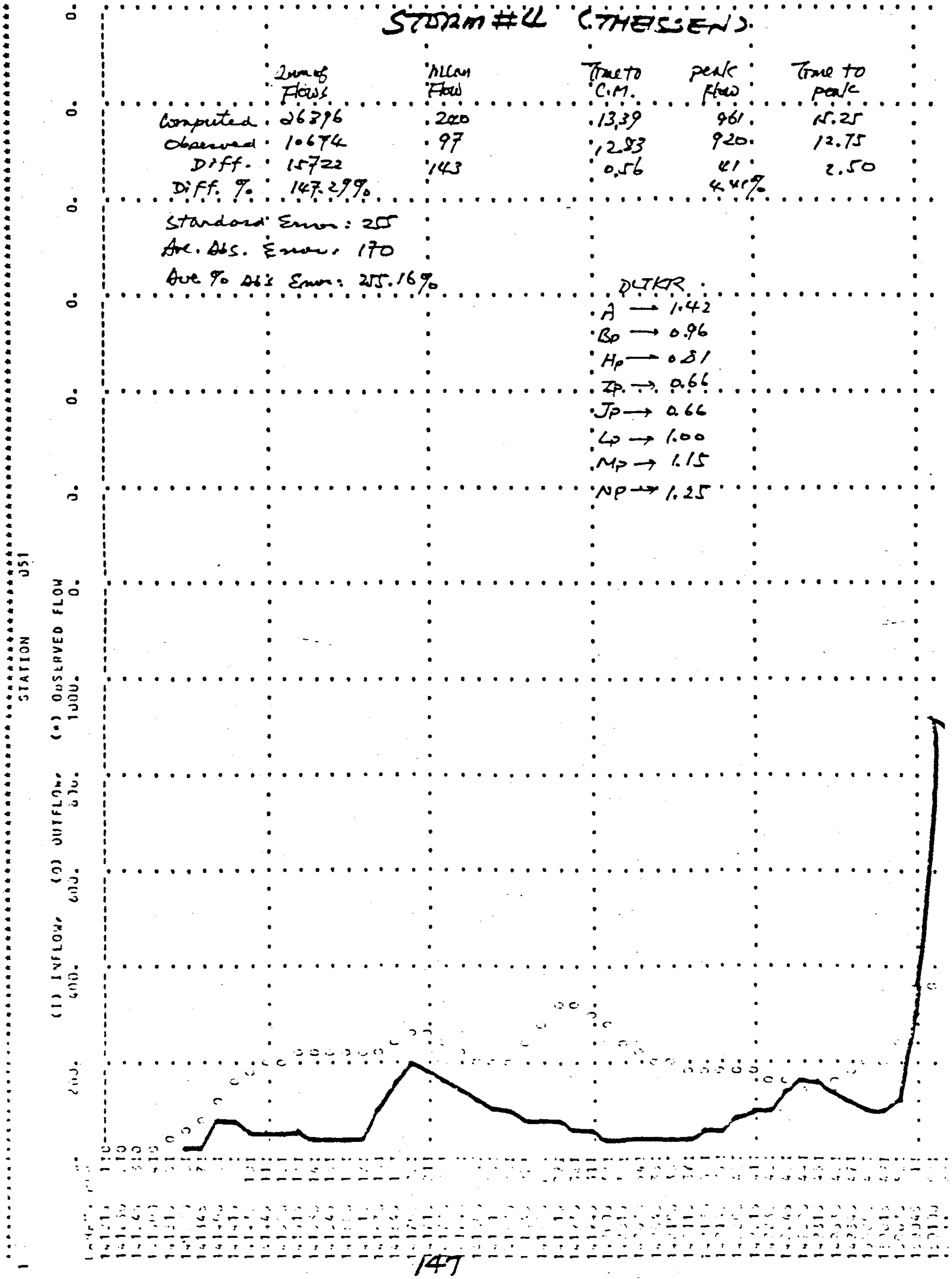
Run # 8.P1

STORM #4 (THEISSEN)

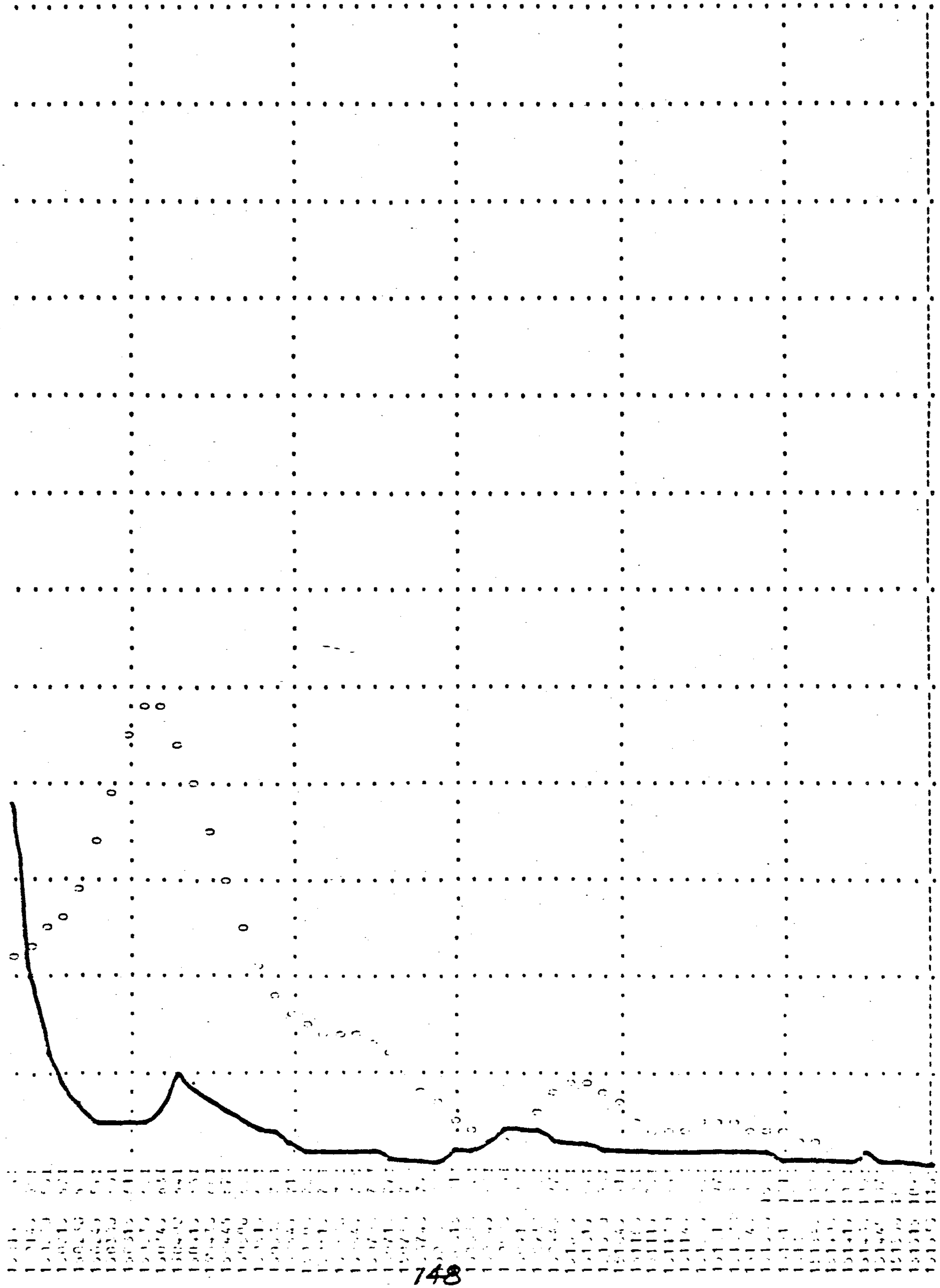
	Sum of Flows	Mean Flow	Time to C.M.	peak Flow	Time to peak
Computed	26396	200	13.39	961	15.25
Observed	10674	97	12.83	920	12.75
Diff.	15722	143	0.56	41	2.50
Diff. %	147.29%			4.46%	

Standard Error: 255
Ave. Abs. Error: 170
Ave % Abs Error: 255.16%

DLTKR
A → 1.42
Bp → 0.96
Hp → 0.81
Zp → 0.66
Jp → 0.66
Lp → 1.00
Mp → 1.15
Np → 1.25



Run 58 P=



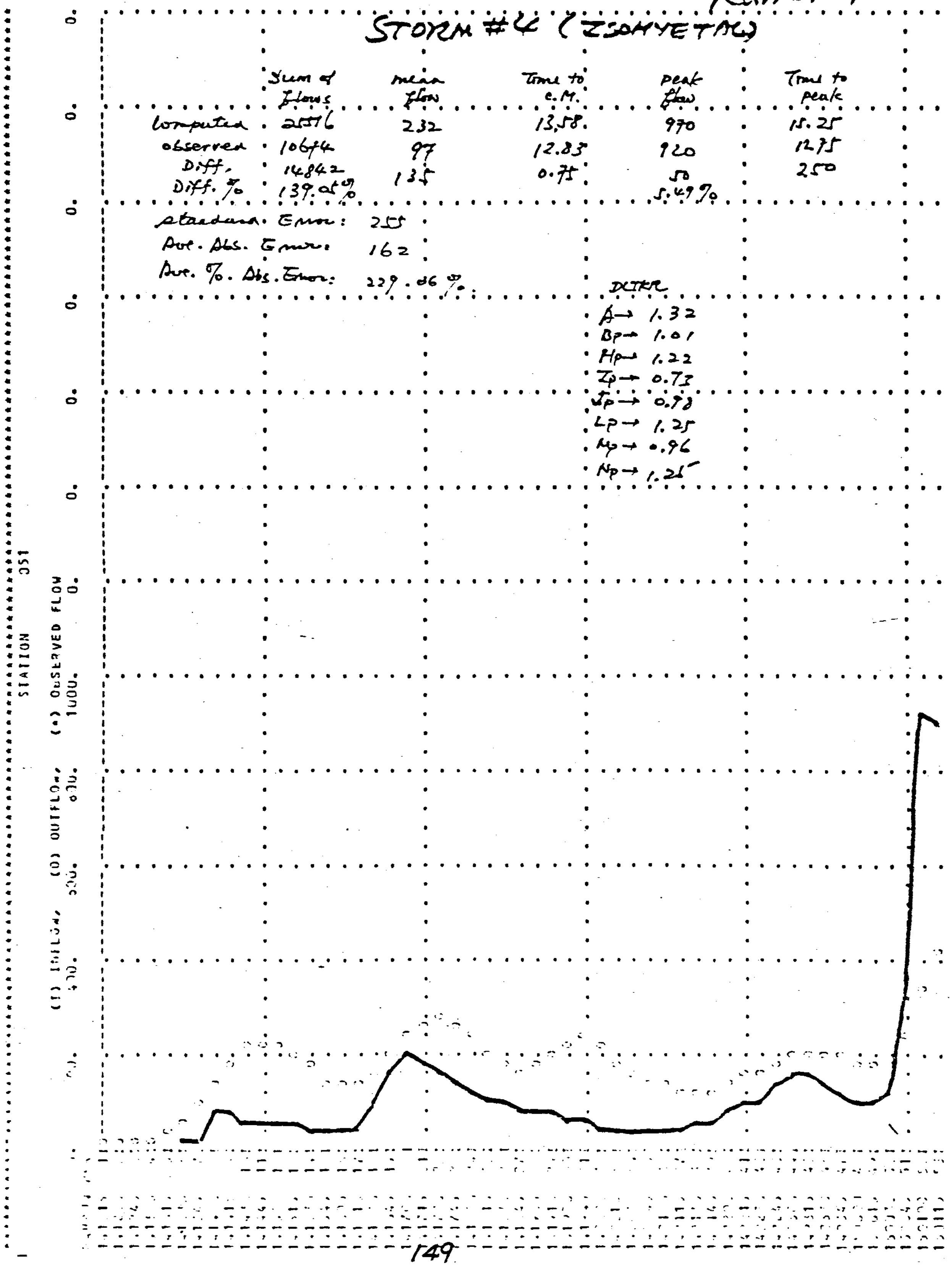
Run 59 p1

STORM #4 (ISOHYETAL)

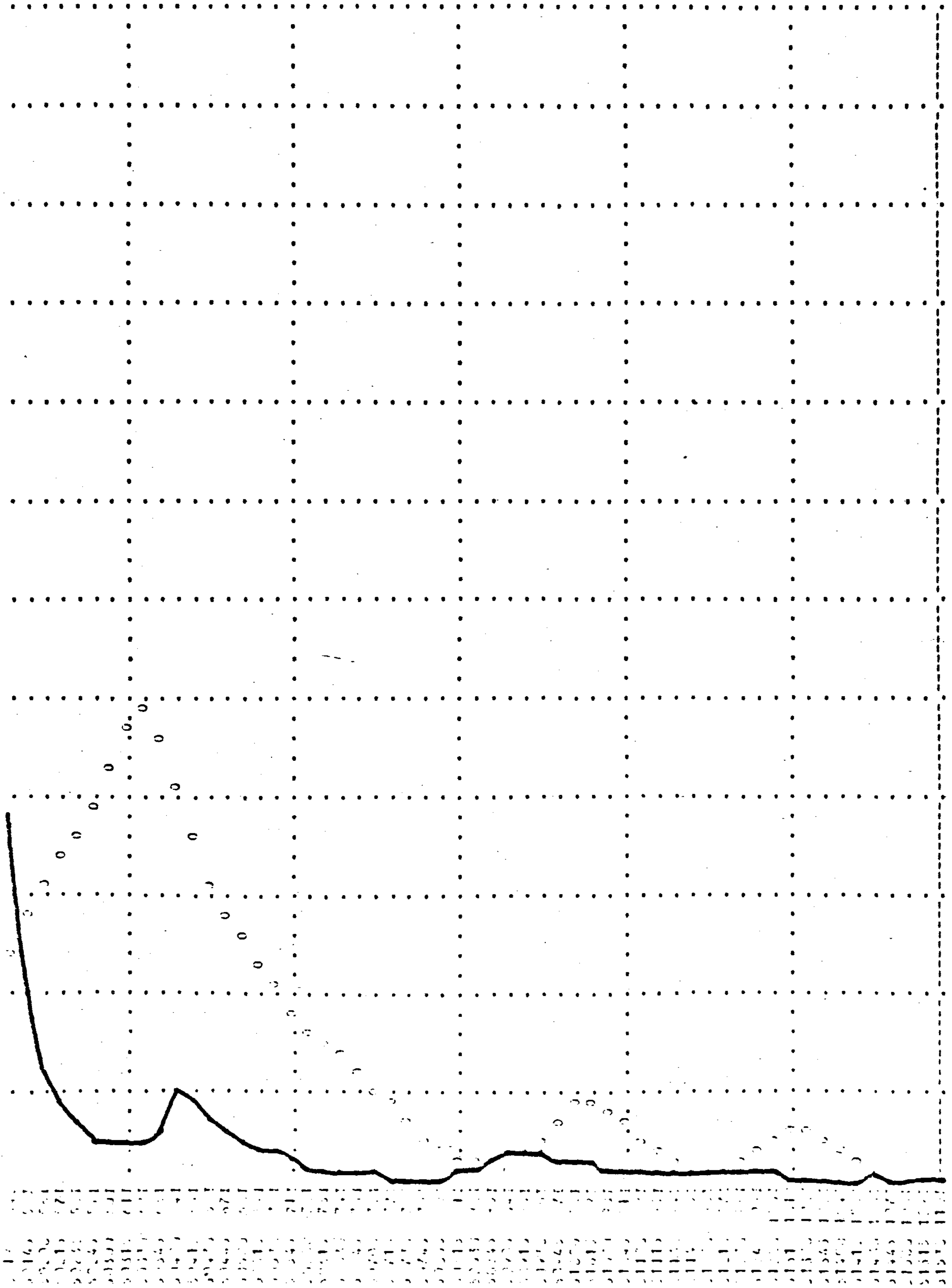
	Sum of Flows	mean flow	Time to c.M.	peak flow	Time to peak
Computed	25516	232	13.58	970	15.25
observed	10674	97	12.83	920	12.75
Diff.	14842	135	0.75	50	250
Diff. %	139.05%			5.49%	

Standard Error: 255
Ave. Abs. Error: 162
Ave. %. Abs. Error: 229.06%

DCTKR
Ap → 1.32
Bp → 1.01
Hp → 1.22
Zp → 0.73
Jp → 0.78
Lp → 1.25
Mp → 0.96
Np → 1.25



Run 59 P2.

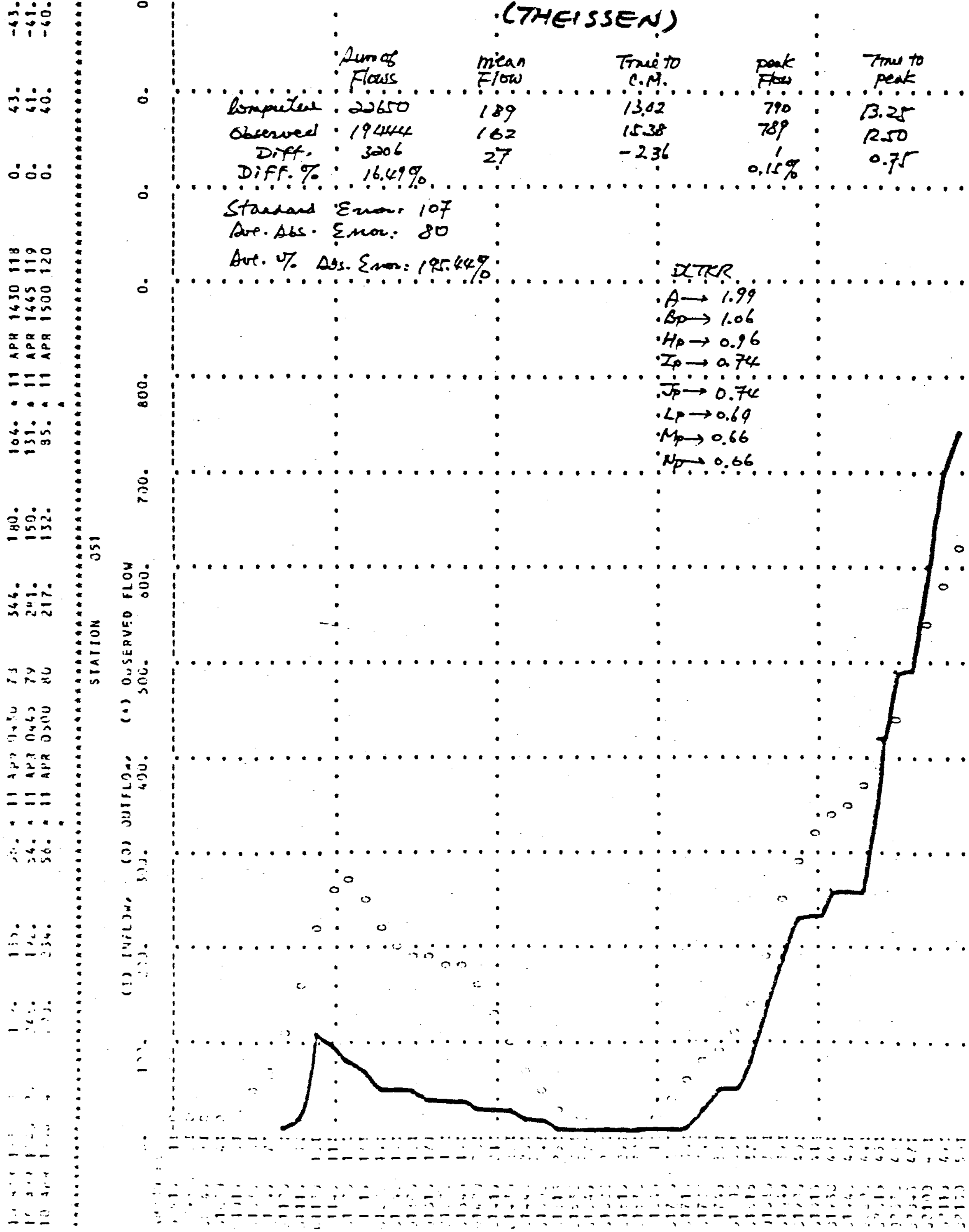


STORM # 5 (THEISSEN) Run 60. P1

	Sum of Flows	mean Flow	Time to C.M.	peak Flow	Time to peak
Computed	22650	189	13.02	790	13.25
Observed	19444	162	15.38	789	12.50
Diff.	3206	27	-2.36	1	0.75
Diff. %	16.49%			0.15%	

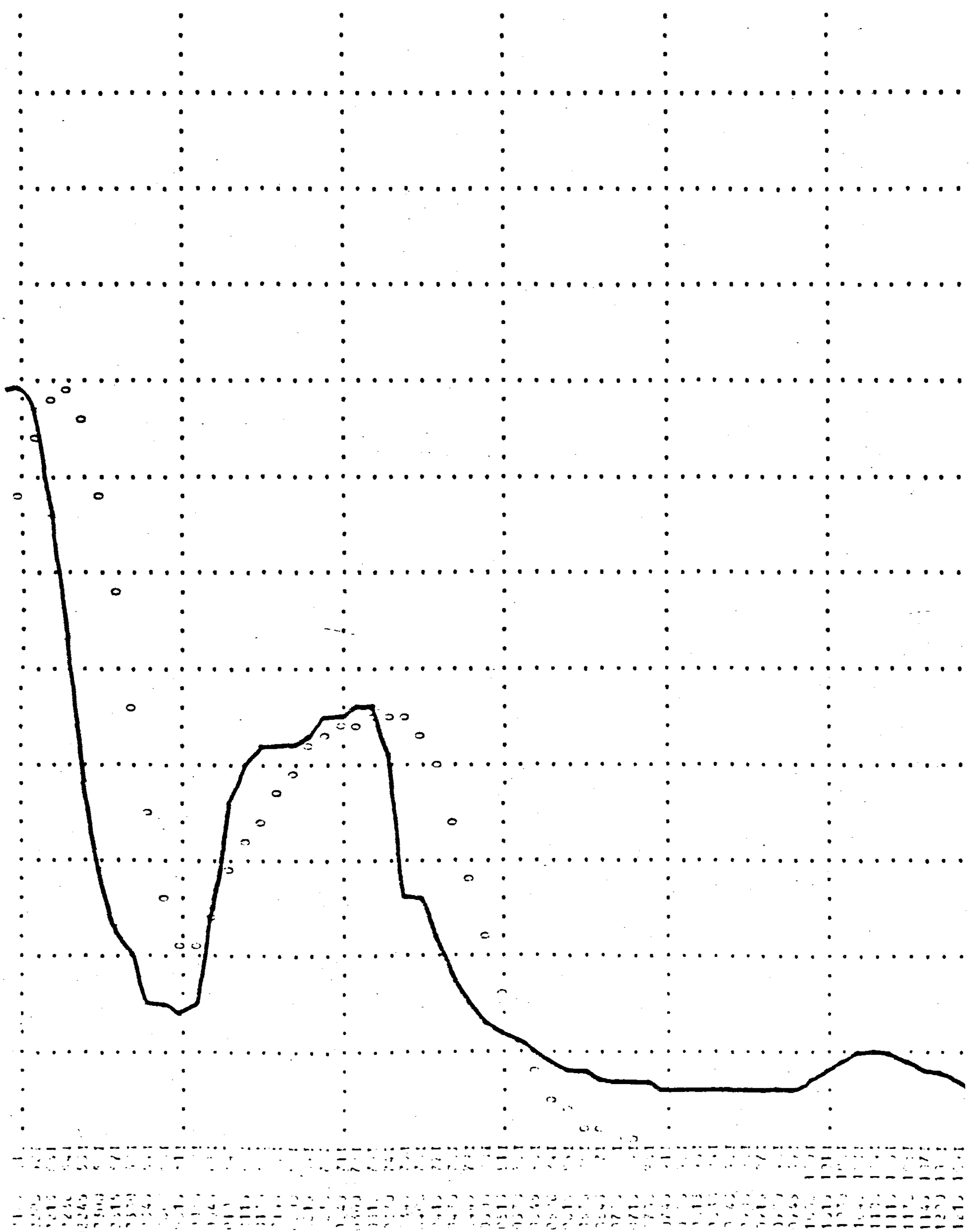
Standard Error: 107
Ave. Abs. Error: 80
Ave. % Abs. Error: 195.44%

DLTKR
A → 1.99
Bp → 1.06
Hp → 0.96
Ip → 0.74
Jp → 0.74
Lp → 0.69
Mp → 0.66
Np → 0.66



157

Run60. P2



RWI61.P1

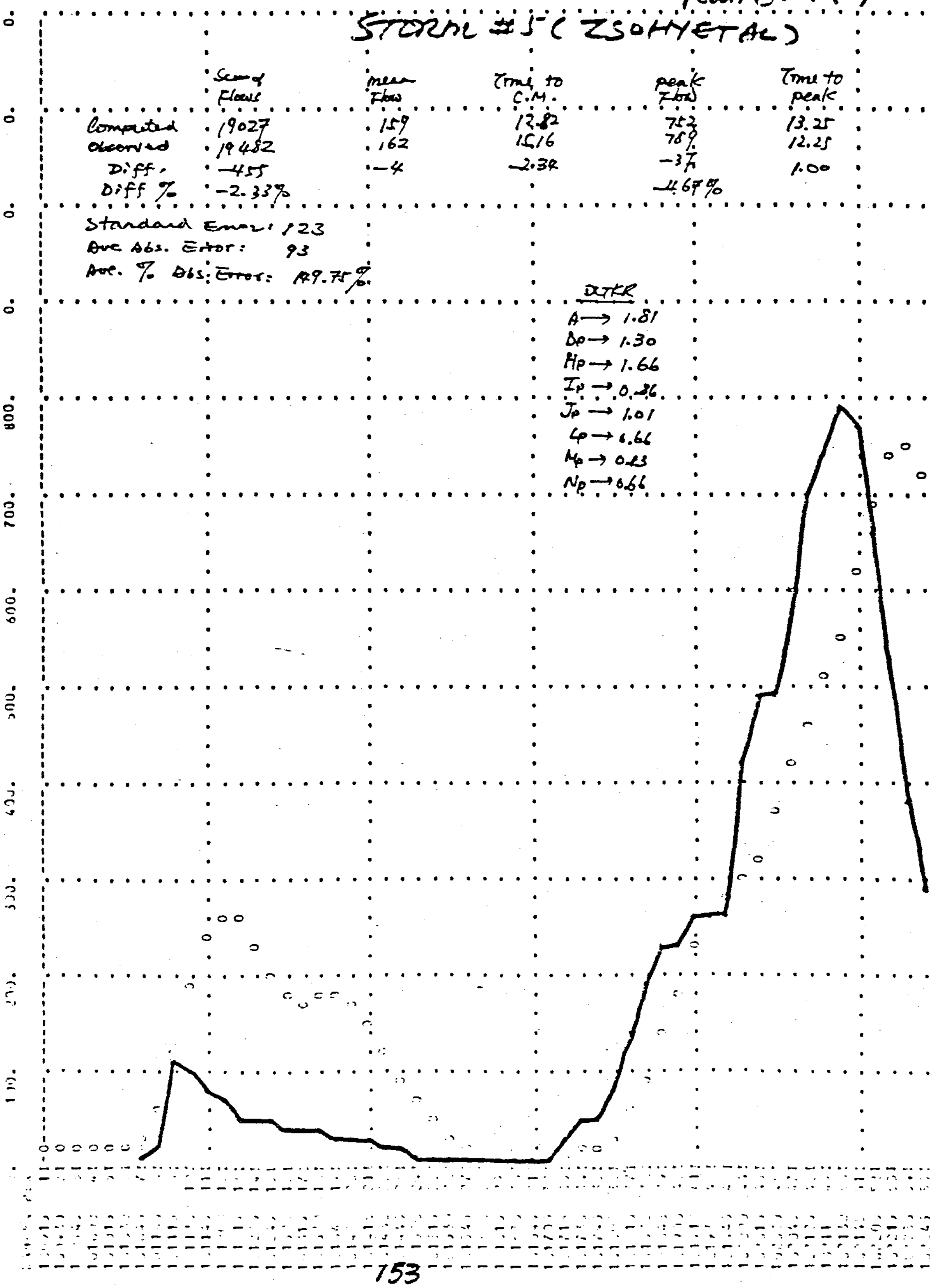
STORM #5 (ISOHYETAL)

	Sum of Flows	mean Flow	Time to C.M.	peak Flow	Time to peak
Computed	19027	159	12.82	752	13.25
Observed	19482	162	15.16	789	12.25
Diff.	-455	-4	-2.34	-37	1.00
Diff %	-2.33%			-4.67%	

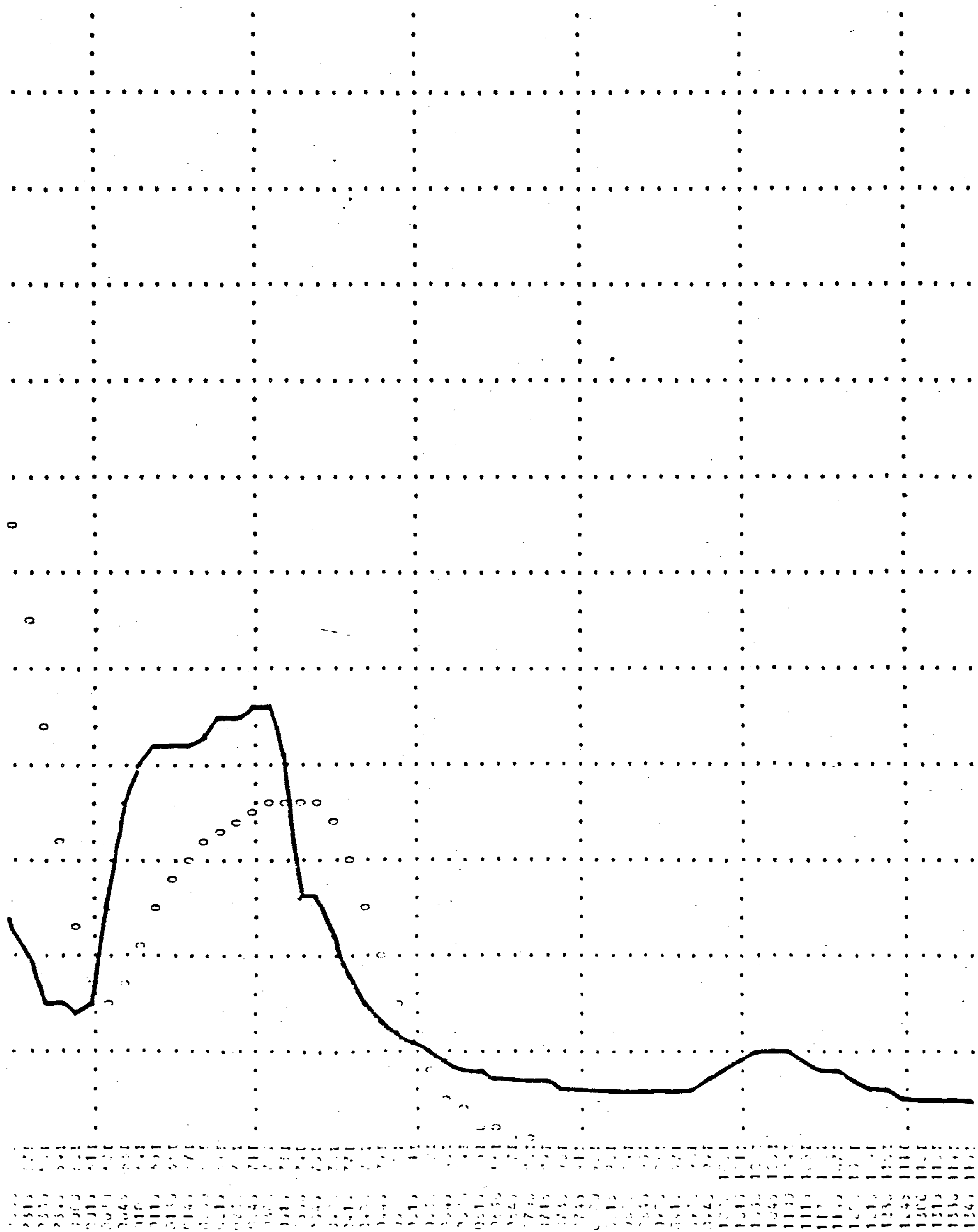
Standard Error: 123
Ave Abs. Error: 93
Ave. % Abs. Error: 29.75%

DTKR

A → 1.81
Bp → 1.30
Hp → 1.66
Ip → 0.86
Jp → 1.01
Lp → 6.66
Mp → 0.23
Np → 0.66



Run 61 . P2



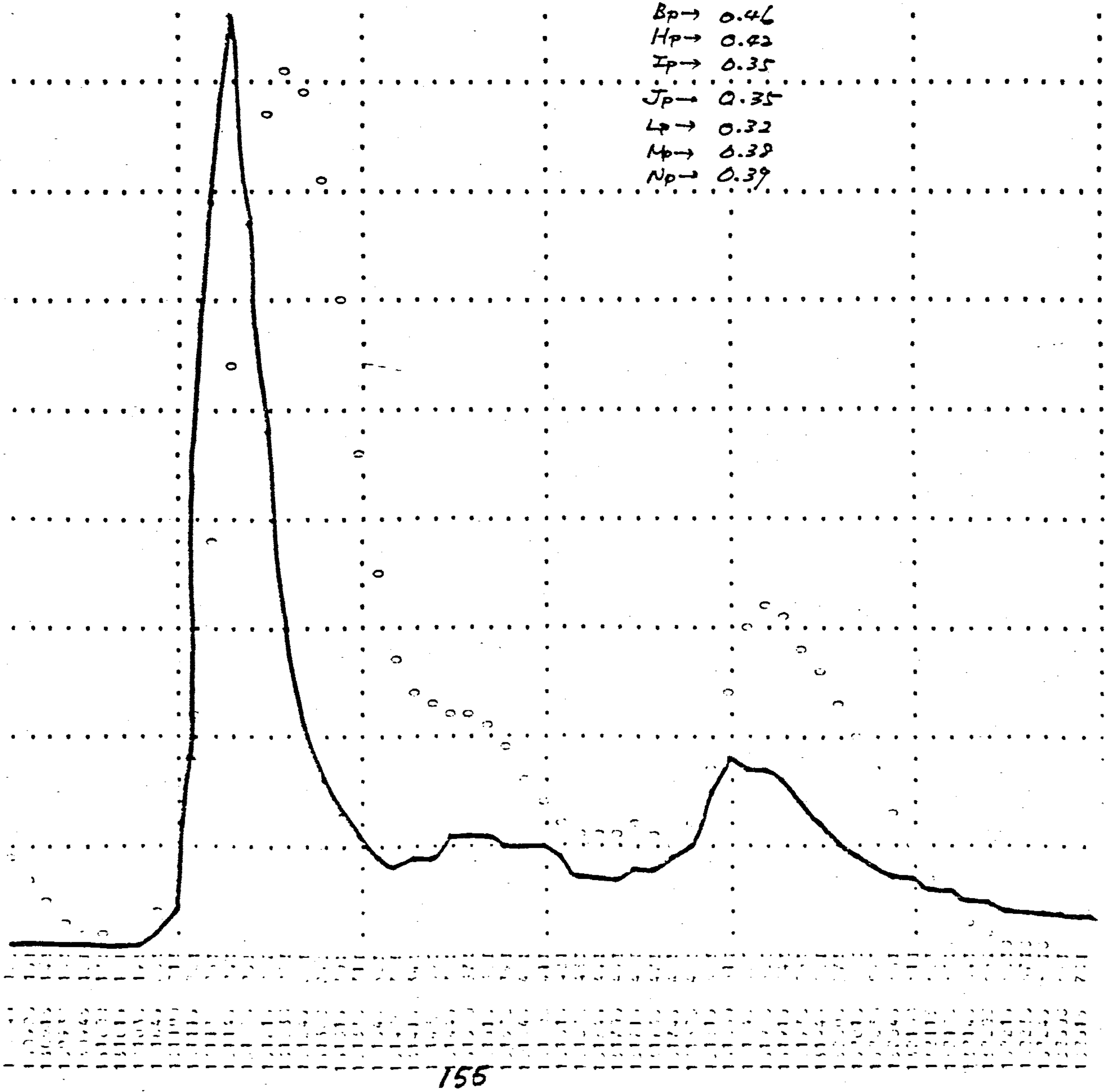
Run 62, P1

STORM #7 (THEISSON)

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to Peak
Computed	13033	181	8.72	810	6.50
observed	7682	107	9.03	862	5.75
Diff.	5351	74	-0.32	-52	0.75
Diff. %	69.66%			-6.04%	

Standard Error: 163
Ave. Abs. Error: 100
Ave. %, Abs. Error: 149.49%

DLTKR
A→ 0.82
Bp→ 0.46
Hp→ 0.42
Ip→ 0.35
Jp→ 0.35
Lp→ 0.32
Mp→ 0.38
Np→ 0.39



STORM # 7 Run 65.P1

(ISOHYETAL)

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to peak
Computed	11784	.164	8.93	.723	6.50
observed	7682	.107	9.03	.862	5.75
Diff.	4102	57	-0.10	-139	
Diff. %	53.39%			-16.17%	0.75

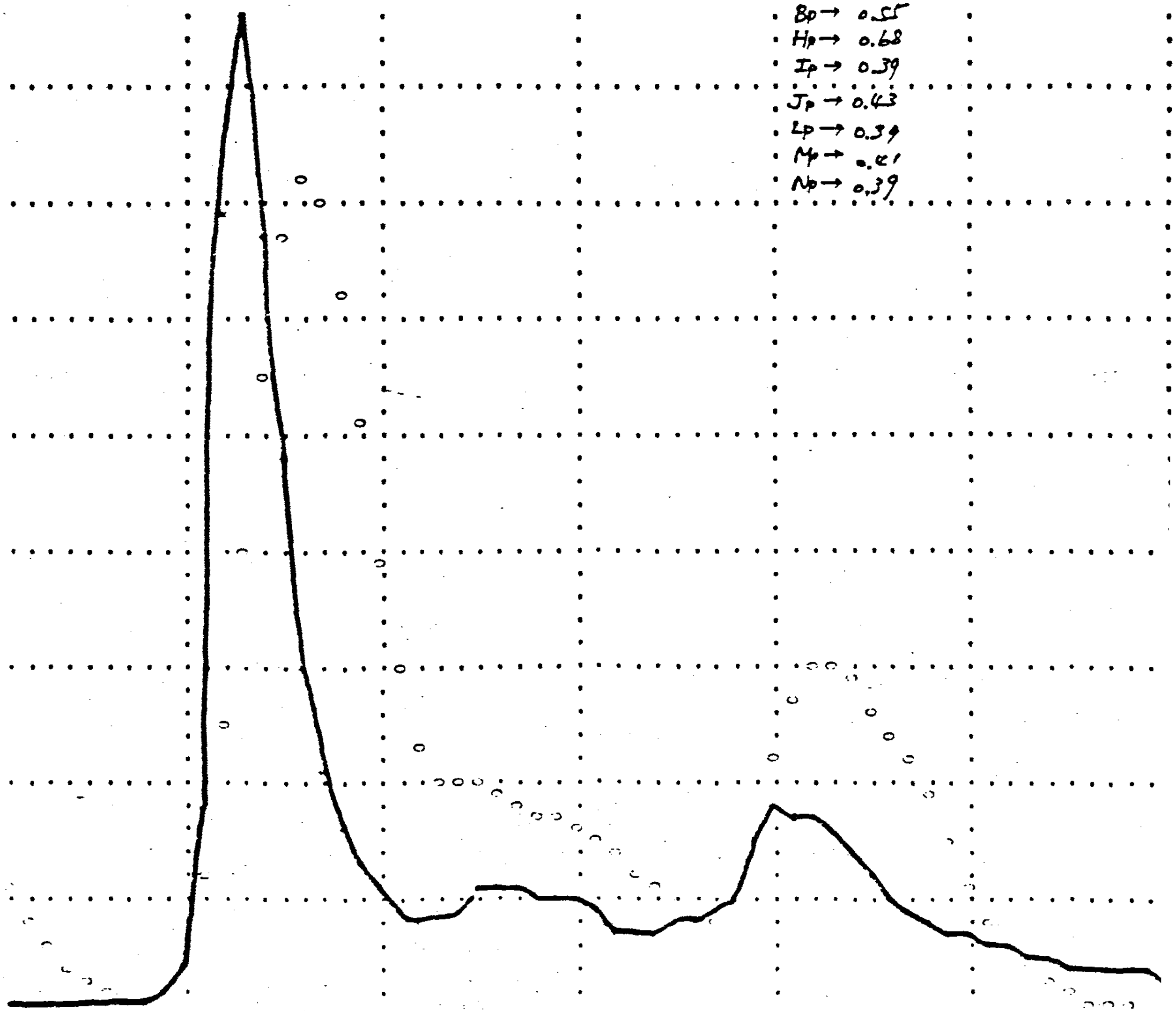
Standard Error: 152

Ave. Abs Error: 94

Ave. % Abs. Error 143.56%

OUTKR

- A → 0.79
- Bp → 0.55
- Hp → 0.68
- Ip → 0.39
- Jp → 0.43
- Lp → 0.39
- Mp → .41
- Np → 0.39



```
 *    OBSERVED HYDROGRAPH          27370.     1.085         342.     7.25      7.25      1149.     6.75     *
 *                                                                                                         *
 *    DIFFERENCF                    8964.     0.355         112.     1.35      1.35        78.     1.50     *
 *    PERCENT DIFFERENCE            32.75                                     18.59       6.78              *
 *                                                                                                         *
 *                   STANDARD ERROR       322.                 AVERAGE ABSOLUTE ERROR      241.             *
 *                OBJECTIVE FUNCTION      340.         AVERAGE PERCENT ABSOLUTE ERROR    120.47             *
 *                                                                                                         *
 ***********************************************************************************************************

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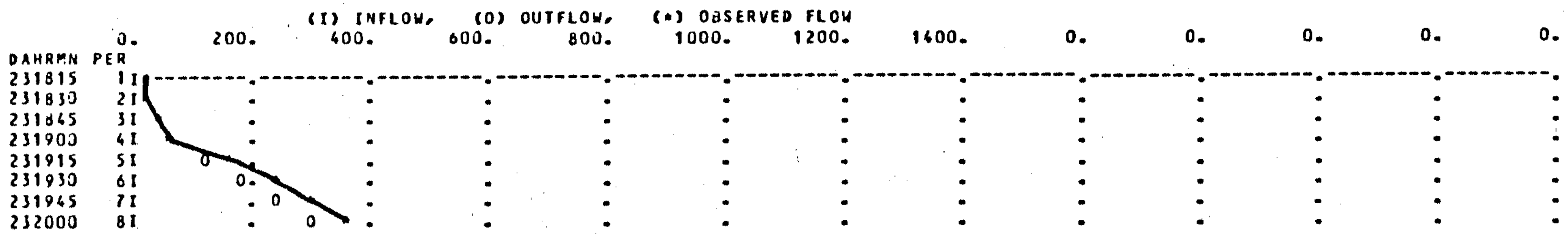
                                          HYDROGRAPH AT STATION      051

****************************************************************************************************************
                                                  *                                                   *
 DA MON HRMN ORD   COMP Q    OBS Q   RESIDUL * DA MON HRMN ORD   COMP Q    OBS Q   RESIDUL * DA MON HRMN ORD   COMP Q    OBS Q   RESIDUL
                                                  *                                                   *
 23 JAN 1815   1      21.      22.       -1. * 24 JAN 0100  28     858.    1149.     -291. * 24 JAN 0745  55     370.     107.      263.
 23 JAN 1830   2      21.      22.       -1. * 24 JAN 0115  29     902.    1134.     -232. * 24 JAN 0800  56     394.     107.      287.
 23 JAN 1845   3      31.      32.       -1. * 24 JAN 0130  30     964.    1067.     -103. * 24 JAN 0815  57     412.     102.      310.
 23 JAN 1900   4      61.      57.        4. * 24 JAN 0145  31    1048.     964.       84. * 24 JAN 0830  58     412.      90.      322.
 23 JAN 1915   5     111.     150.      -39. * 24 JAN 0200  32    1144.     772.      372. * 24 JAN 0845  59     390.      90.      300.
 23 JAN 1930   6     176.     234.      -58. * 24 JAN 0215  33    1216.     608.      608. * 24 JAN 0900  60     349.      81.      268.
 23 JAN 1945   7     243.     299.      -56. * 24 JAN 0230  34    1227.     469.      758. * 24 JAN 0915  61     291.      81.      210.
 23 JAN 2000   8     303.     355.      -52. * 24 JAN 0245  35    1170.     365.      805. * 24 JAN 0930  62     216.      77.      139.
 23 JAN 2015   9     353.     359.       -6. * 24 JAN 0300  36    1074.     301.      773. * 24 JAN 0945  63     139.      67.       72.
 23 JAN 2030  10     394.     352.       42. * 24 JAN 0315  37     976.     301.      675. * 24 JAN 1000  64      83.      67.       16.
 23 JAN 2045  11     424.     369.       55. * 24 JAN 0330  38     895.     460.      435. * 24 JAN 1015  65      51.      67.      -16.
 23 JAN 2100  12     443.     405.       38. * 24 JAN 0345  39     838.     567.      271. * 24 JAN 1030  66      32.      65.      -33.
 23 JAN 2115  13     455.     414.       41. * 24 JAN 0400  40     801.     538.      263. * 24 JAN 1045  67      21.      61.      -40.
 23 JAN 2130  14     467.     384.       83. * 24 JAN 0415  41     785.     458.      327. * 24 JAN 1100  68      14.      59.      -45.
 23 JAN 2145  15     476.     331.      145. * 24 JAN 0430  42     787.     365.      422. * 24 JAN 1115  69      10.      59.      -49.
 23 JAN 2200  16     473.     312.      161. * 24 JAN 0445  43     801.     299.      502. * 24 JAN 1130  70       7.      59.      -52.
 23 JAN 2215  17     456.     388.       68. * 24 JAN 0500  44     811.     245.      566. * 24 JAN 1145  71       5.      57.      -52.
 23 JAN 2230  18     442.     629.     -187. * 24 JAN 0515  45     807.     202.      605. * 24 JAN 1200  72       3.      55.      -52.
 23 JAN 2245  19     443.     797.     -354. * 24 JAN 0530  46     783.     175.      608. * 24 JAN 1215  73       2.      55.      -53.
 23 JAN 2300  20     474.     912.     -438. * 24 JAN 0545  47     739.     151.      588. * 24 JAN 1230  74       2.      51.      -49.
 23 JAN 2315  21     520.     969.     -449. * 24 JAN 0600  48     679.     136.      543. * 24 JAN 1245  75       1.      51.      -50.
 23 JAN 2330  22     584.    1034.     -450. * 24 JAN 0615  49     611.     116.      495. * 24 JAN 1300  76       1.      51.      -50.
 23 JAN 2345  23     652.    1070.     -418. * 24 JAN 0630  50     539.     116.      423. * 24 JAN 1315  77       1.      49.      -48.
 24 JAN 0000  24     711.    1074.     -363. * 24 JAN 0645  51     462.     108.      354. * 24 JAN 1330  78       0.      49.      -49.
 24 JAN 0015  25     758.    1072.     -314. * 24 JAN 0700  52     392.     101.      291. * 24 JAN 1345  79       0.      46.      -46.
 24 JAN 0030  26     793.    1093.     -300. * 24 JAN 0715  53     356.      99.      257. * 24 JAN 1400  80       0.      40.      -40.
 24 JAN 0045  27     824.    1127.     -303. * 24 JAN 0730  54     354.      99.      255. *
                                                  *                                                   *
****************************************************************************************************************
1                                                      STATION      051
```

157



```
                         (I) INFLOW,   (O) OUTFLOW,   (*) OBSERVED FLOW
          0.       200.      400.      600.      800.     1000.     1200.     1400.       0.        0.        0.        0.        0.
DAHRMN PER
231815   1I---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
231830   2I         .         .         .         .         .         .         .         .         .         .         .         .
231845   3I         .         .         .         .         .         .         .         .         .         .         .         .
231900   4I         .         .         .         .         .         .         .         .         .         .         .         .
231915   5I    0    .         .         .         .         .         .         .         .         .         .         .         .
231930   6I        0.         .         .         .         .         .         .         .         .         .         .         .
231945   7I         . 0       .         .         .         .         .         .         .         .         .         .         .
232000   8I         .    0    .         .         .         .         .         .         .         .         .         .         .
```

RUN 64 P1

RUN 64 P2

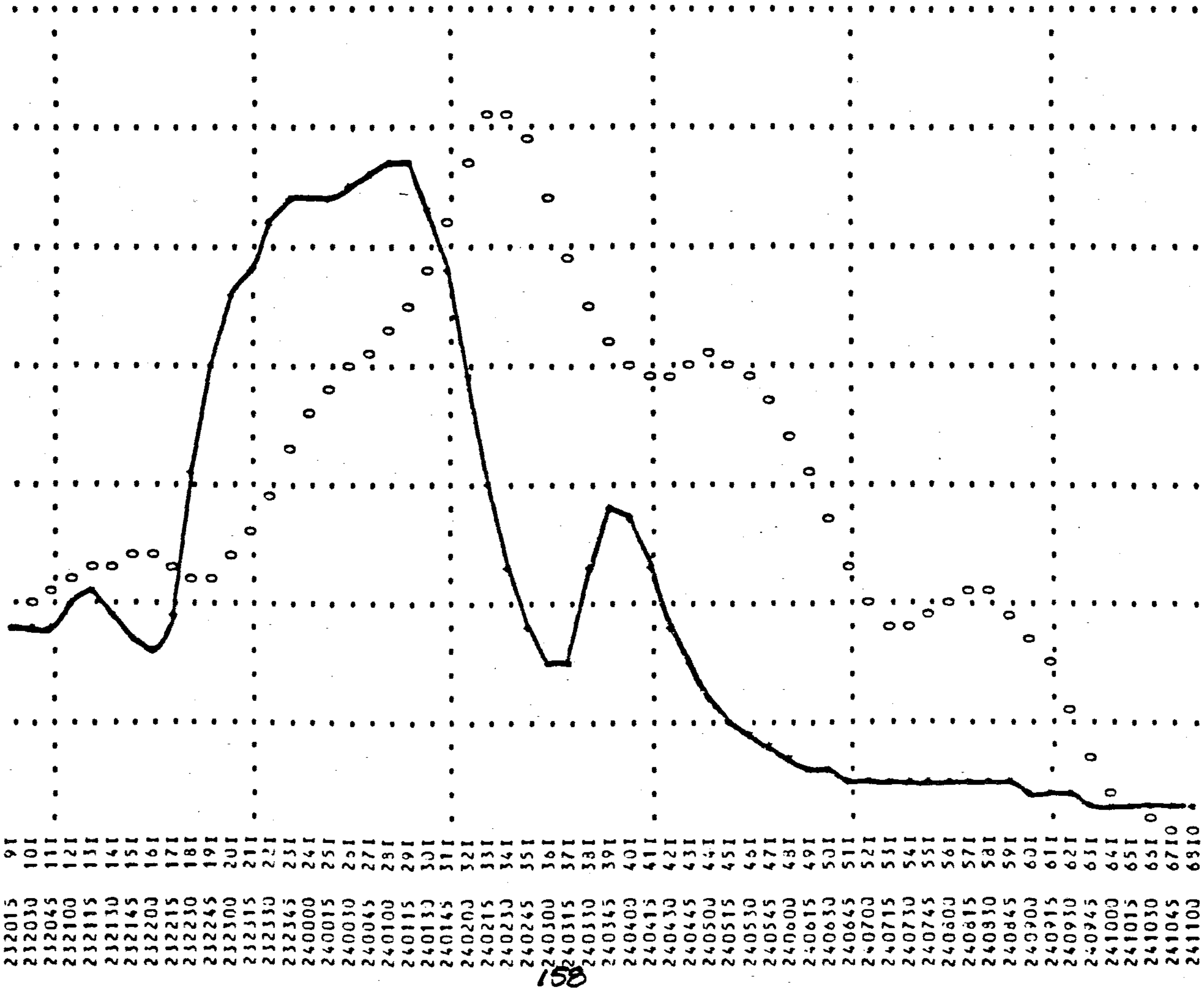
	STORM #1	(THEISSEN).			
	SUM of Flow.	mean Flow.	Time to C.M.	Peak Flow	Time of Peak.
Computed	36334	454	8.59	1227	8.25
observed	27370	342	7.25	1149	6.75
diff.	8964	112	1.35	78	1.50
%	32.75 %			6.78 %	

Standard Error 322
Ave. Abs. Error 241
Ave. % Abs. Error 120.47 %.

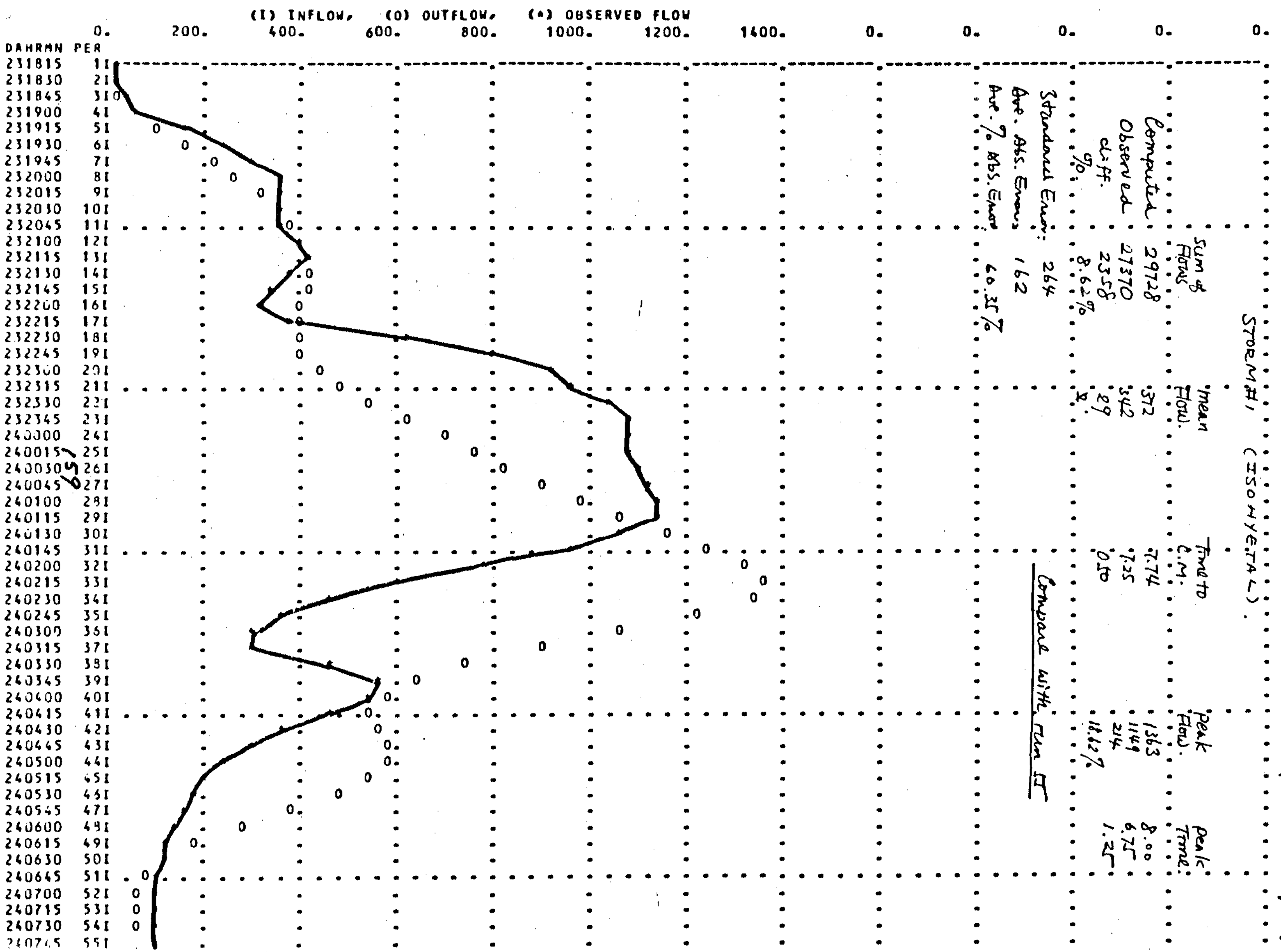
Idea: Reduce STRKR (by 50%)
Compensate by increasing DLTKR (by 100%)
to see if the peak moves.

This test is conducted for storm #1 (RUN 64, 65)
Storm #2 (RUN 66, 67)
Storm #5 (RUN 68, 69)
For their similarity.

All data based on previous run
∴ Compare RUN 64 with RUN 54.



STATION 051



STORM #1 (ISOHYETAL).

	Sum of Flows	mean Flow.	Time to C.M.	peak Flow.	peak Time:
Computed	29728	372	7.74	1363	8.00
Observed	27370	342	7.25	1149	6.75
diff.	2358	29	0.50	214	1.25
%	8.62%	8.		18.62%	

Standard Error: 264

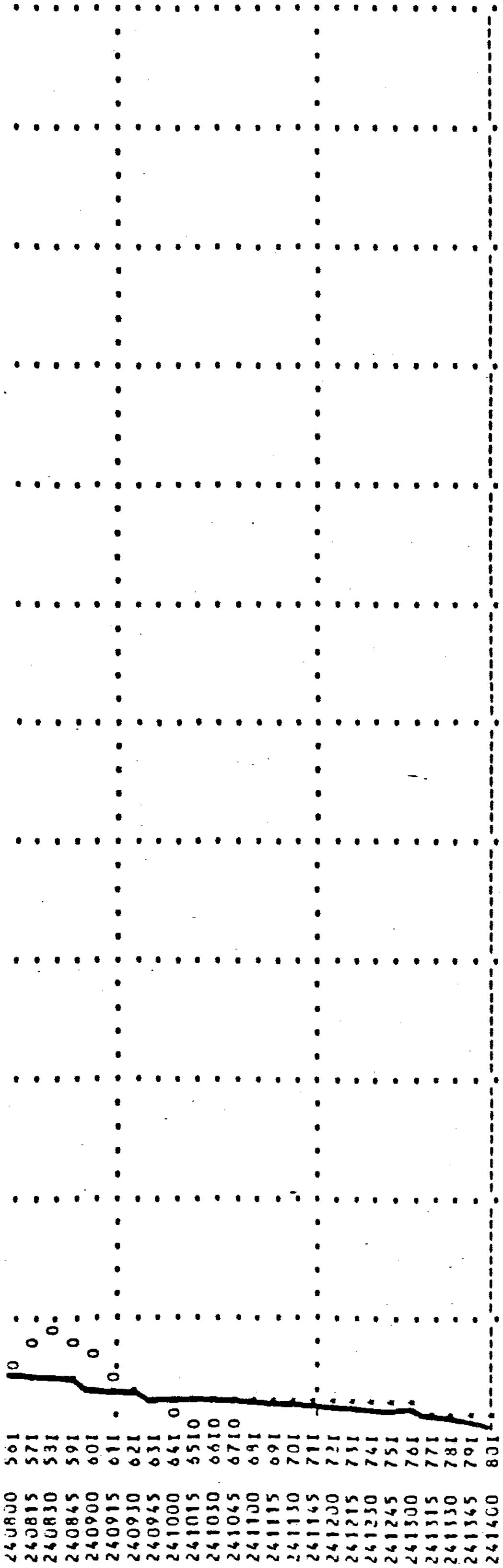
Ave. Abs. Error: 162

Ave. % Abs. Error: 60.35%

Compare with run II

RUN 65 P1.

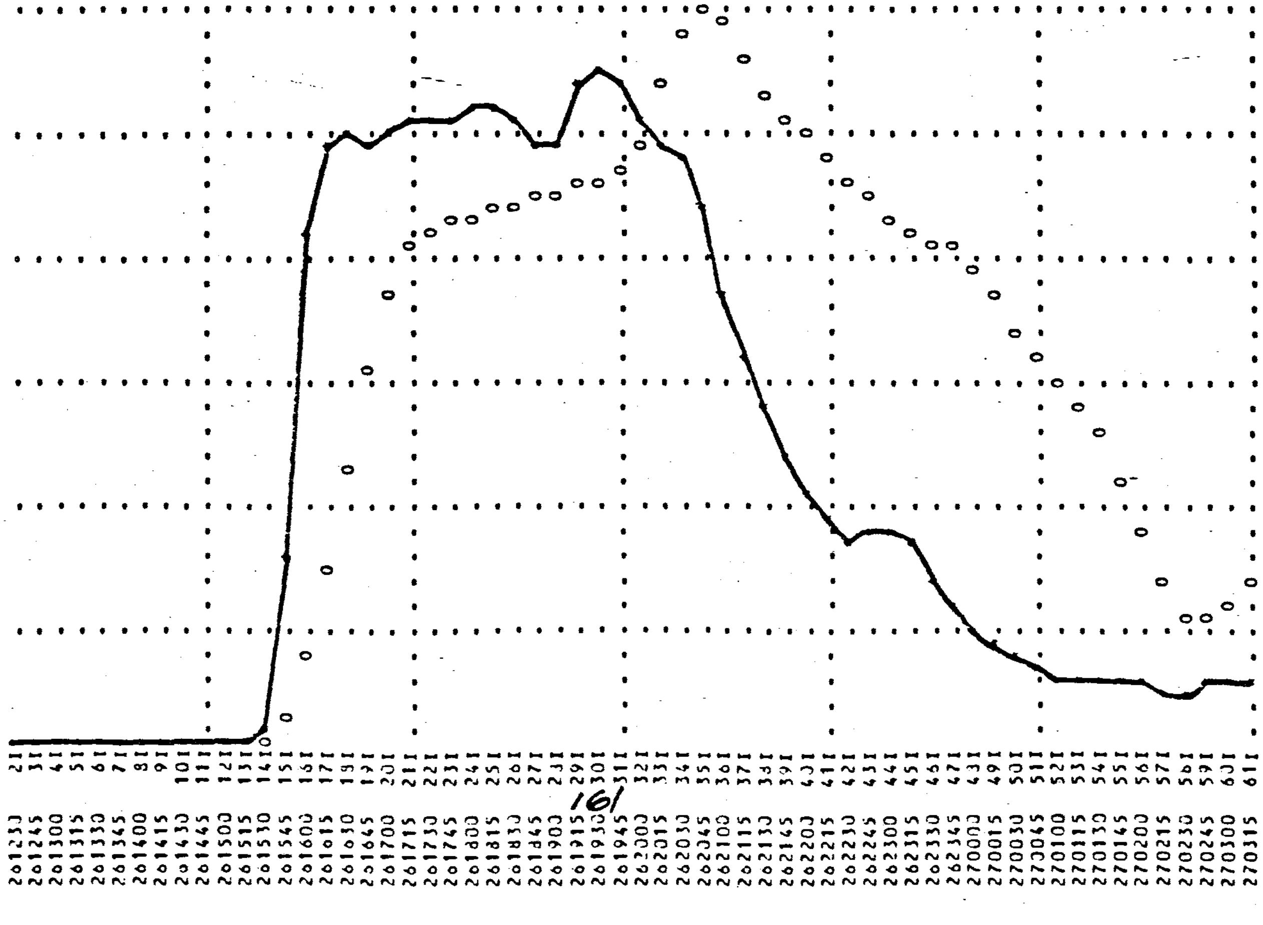
RUN 65 P2

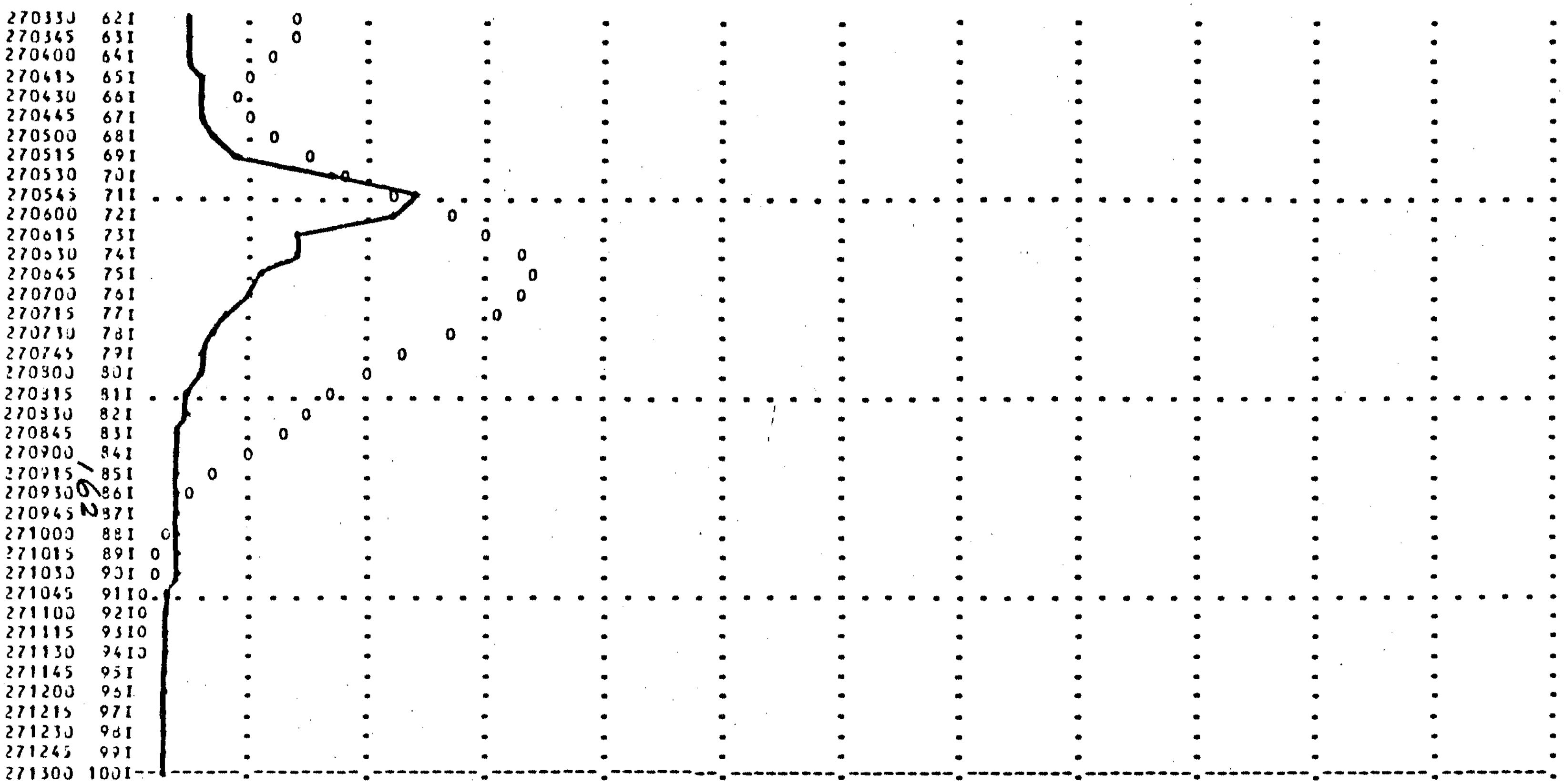

240800 561
240815 571
240830 531
240845 591
240900 601
240915 611
240930 621
240945 631
241000 641
241015 6510
241030 6610
241045 6710
241100 691
241115 691
241130 701
241145 711
241200 721
241215 731
241230 741
241245 751
241300 761
241315 771
241330 781
241345 791
241400 801

RUN 66 P1

STORM # 2 (THEISSEN)

	Sum of Flows	mean Flow	Time to C.M.	Peak Flow.	peak Time.
Computed	44235	442	11.18	1197	8.50
Observed	32721	327	9.36	1099	7.25
diff.	11514	115	1.83	98	1.25
%	35.19%			8.90%	
Standard error:	297				
Ave. Abs. error:	218		Compare with	RUN 56	
Ave. % Abs. error:	108.17%				





162

Run66 P2.

```
                                        RUNOFF SUMMARY
                                 FLOW IN CUBIC FEET PER SECOND
                              TIME IN HOURS,  AREA IN SQUARE MILES

                                       PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD       BASIN    MAXIMUM     TIME OF
  OPERATION          STATION           FLOW     PEAK                                              AREA     STAGE     MAX STAGE
                                                              6-HOUR       24-HOUR      72-HOUR

  HYDROGRAPH AT
                          00A          620.     7.25           273.         127.         123.      2.98

  ROUTED TO
                         1T02          534.     7.75           272.         127.         123.      2.98

  HYDROGRAPH AT
                          008          152.     3.50            90.          31.          30.      0.38

  HYDROGRAPH AT
                          008           84.     7.25            21.           7.           6.      0.70
```

RUN 67. P1

STORM #2 (ISOHYETAL)

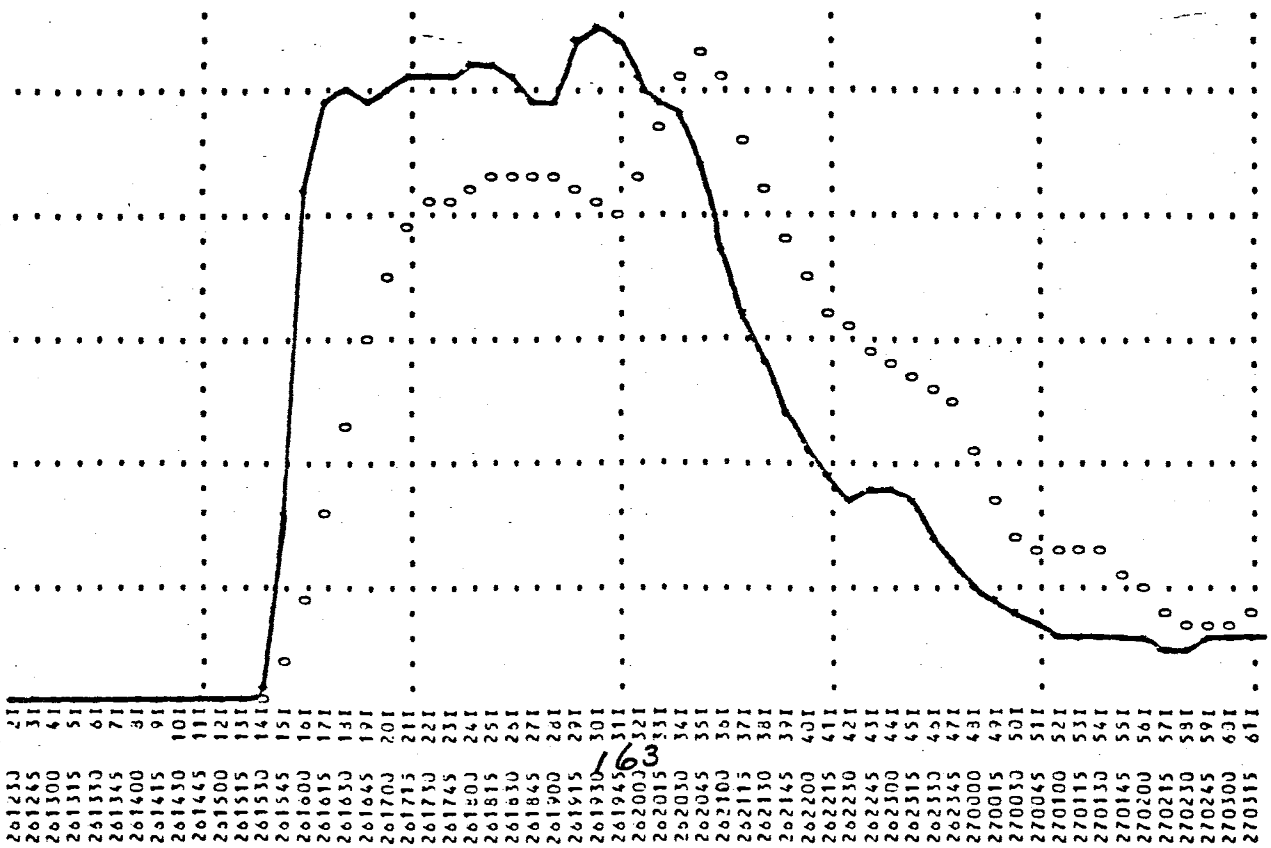
	SUM of Flows	mean Flow	Time to C.M.	peak Flow	peak Time
Computed	34135	341	10.63	1056	8.50
Observed	37271	327	9.36	1099	7.25
Diff.	1414	14	1.27	-43	1.25
%	4.32%			-3.93%	

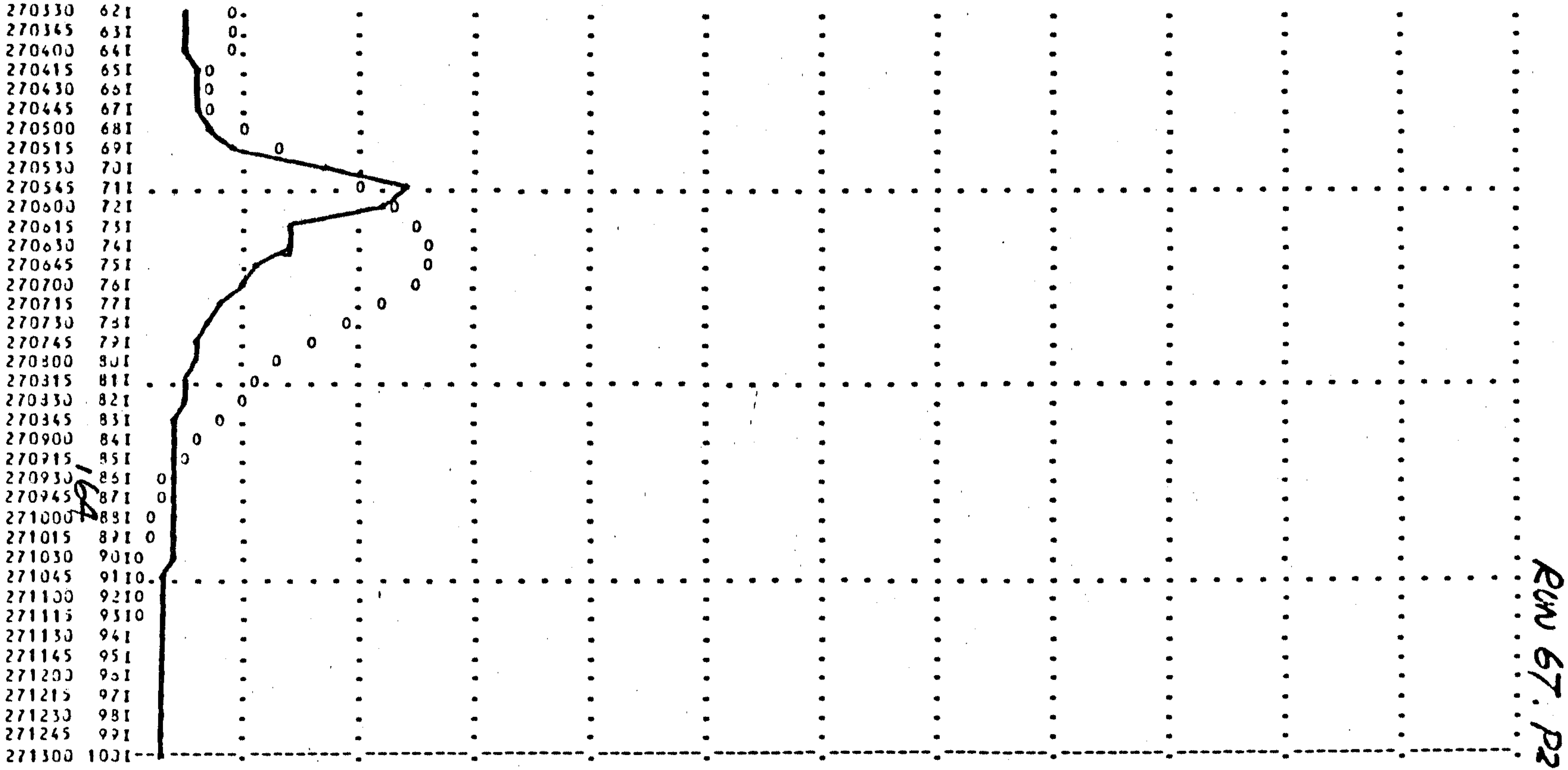
Standard Error: 188

Ave. Abs. Error: 134

Ave. %. Abs Error: 60.13%

Compare with Run 57





RUN 67. P2

```
                                      RUNOFF SUMMARY
                               FLOW IN CUBIC FEET PER SECOND
                            TIME IN HOURS,  AREA IN SQUARE MILES

                                 PEAK    TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM    TIME OF
     OPERATION        STATION    FLOW     PEAK                                            AREA     STAGE    MAX STAGE
                                                    6-HOUR     24-HOUR     72-HOUR

     HYDROGRAPH AT
                        00A      651.     7.25       257.         94.         91.         2.98

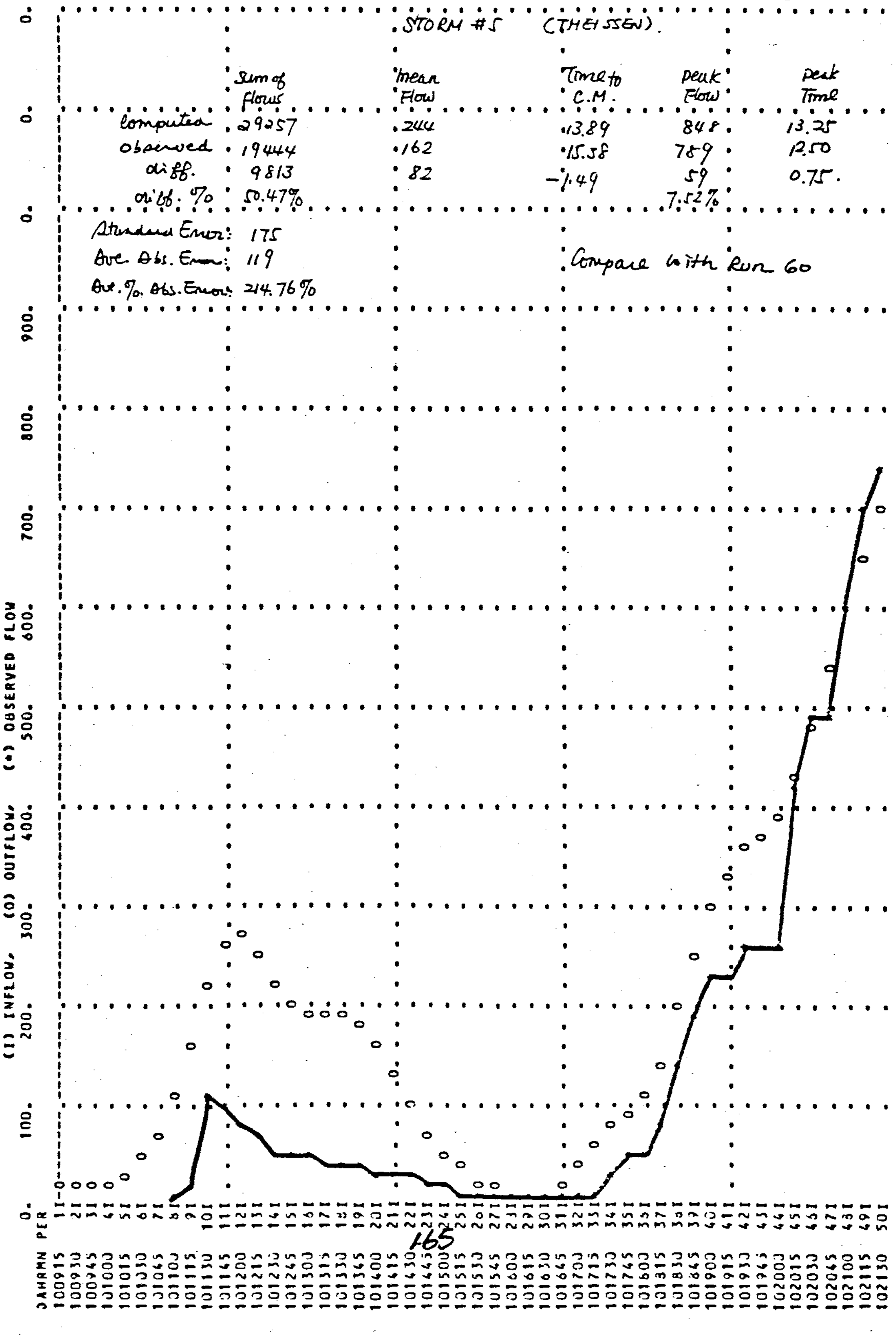
     ROUTED TO
                        1T02     547.     7.75       255.         94.         91.         2.98

     HYDROGRAPH AT
                        00B      137.     3.50        77.         28.         27.         0.38

     HYDROGRAPH AT
                        00B       23.    17.00         8.          4.          4.         0.70
```

RUN 68. P1

```
10 APR 1830  38    195.    136.    59. * 11 APR 0430  78    594.    190.    414. * 11 APR 1430 118     0.    43.    -43.
10 APR 1845  39    252.    192.    60. * 11 APR 0445  79    523.    150.    373. * 11 APR 1445 119     0.    41.    -41.
10 APR 1900  40    300.    234.    66. * 11 APR 0500  80    436.    132.    304. * 11 APR 1500 120     0.    40.    -40.
********************************************************************************************************************
                                       STATION      051
1
```

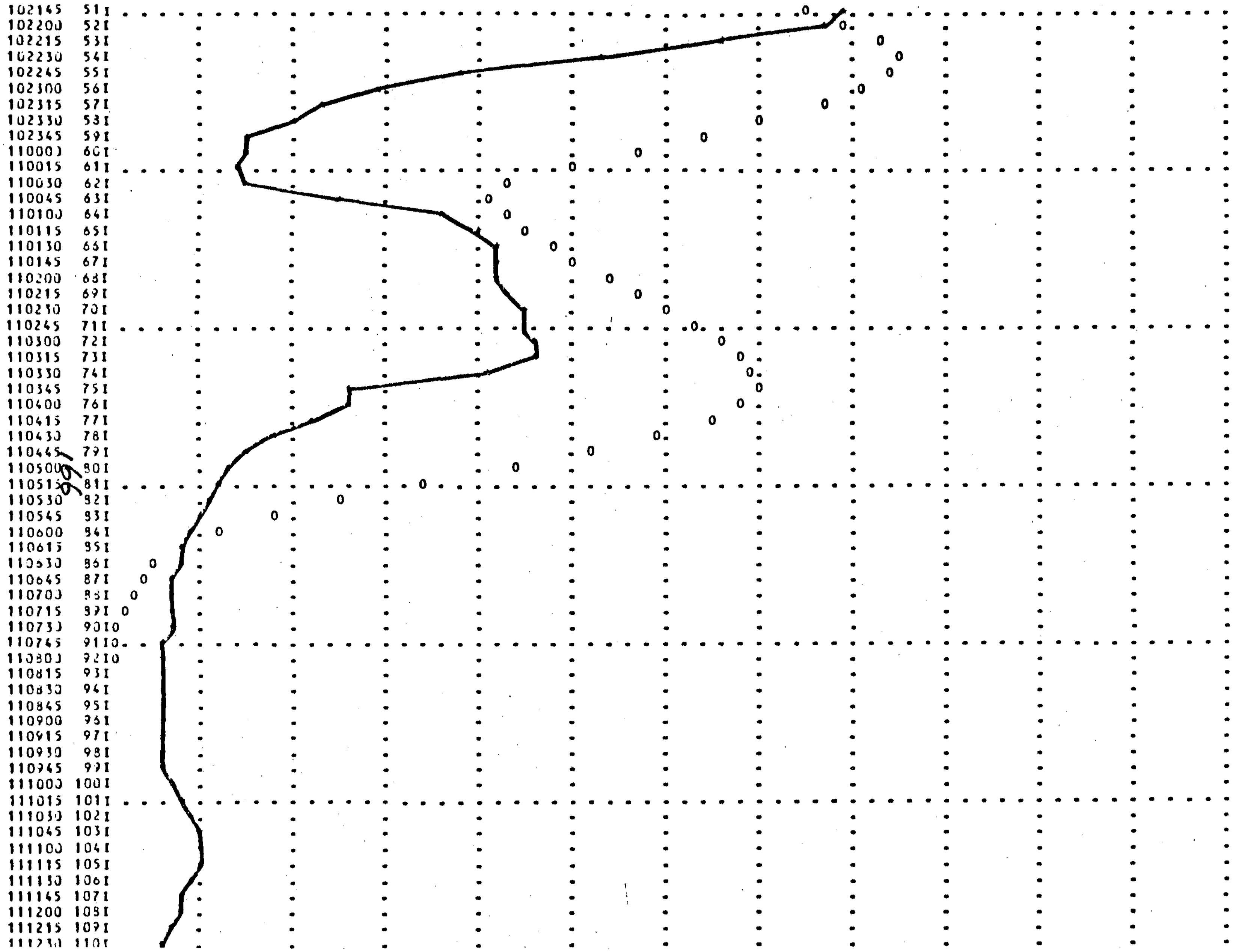


STORM #5 (THEISSEN)

	Sum of Flows	mean Flow	Time to C.M.	peak Flow	peak Time
Computed	29257	244	13.89	848	13.25
observed	19444	162	15.58	789	12.50
diff.	9813	82	-1.49	59	0.75.
diff. %	50.47%			7.52%	

Standard Error: 175
Ave. Abs. Error: 119
Ave. % Abs. Error: 214.76%

Compare with Run 60

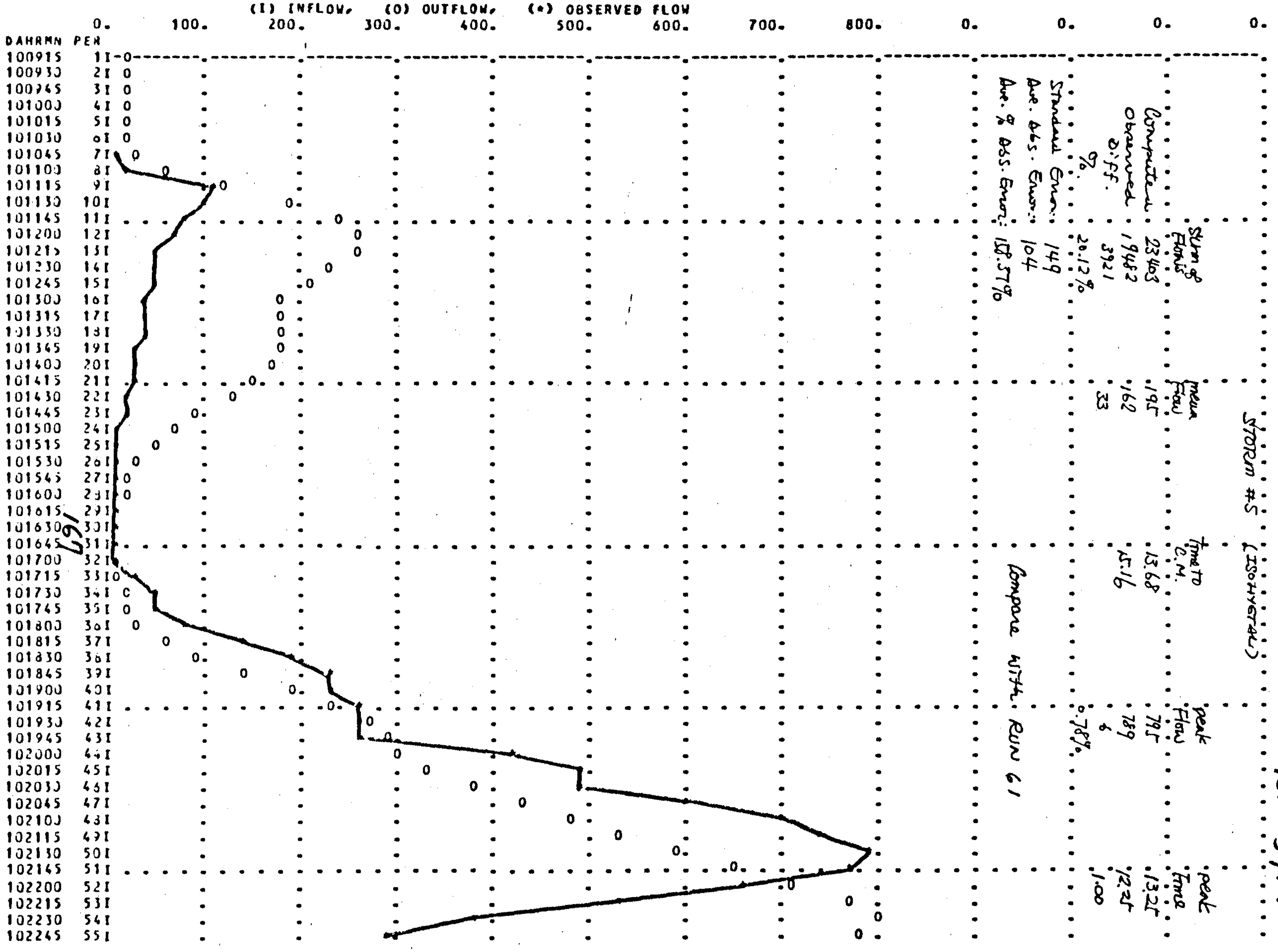

102145 51I
102200 52I
102215 53I
102230 54I
102245 55I
102300 56I
102315 57I
102330 53I
102345 59I
110000 60I
110015 61I
110030 62I
110045 63I
110100 64I
110115 65I
110130 66I
110145 67I
110200 68I
110215 69I
110230 70I
110245 71I
110300 72I
110315 73I
110330 74I
110345 75I
110400 76I
110415 77I
110430 78I
110445 79I
110500 80I
110515 81I
110530 82I
110545 83I
110600 84I
110615 85I
110630 86I
110645 87I
110700 88I
110715 89I
110730 90I
110745 91I
110800 92I
110815 93I
110830 94I
110845 95I
110900 96I
110915 97I
110930 98I
110945 99I
111000 100I
111015 101I
111030 102I
111045 103I
111100 104I
111115 105I
111130 106I
111145 107I
111200 108I
111215 109I
111230 110I

166

Run 68. P2

1

STATION 051



167

STORM #5 (ISOHYETAL)

	Sum of Flows	mean Flow	time to C.M.	peak Flow	peak time
Computed	23403	195	13.68	795	13.25
Observed	19482	162	15.16	789	12.25
Diff.	3921	33		6	1.00
%	20.12%			0.78%	

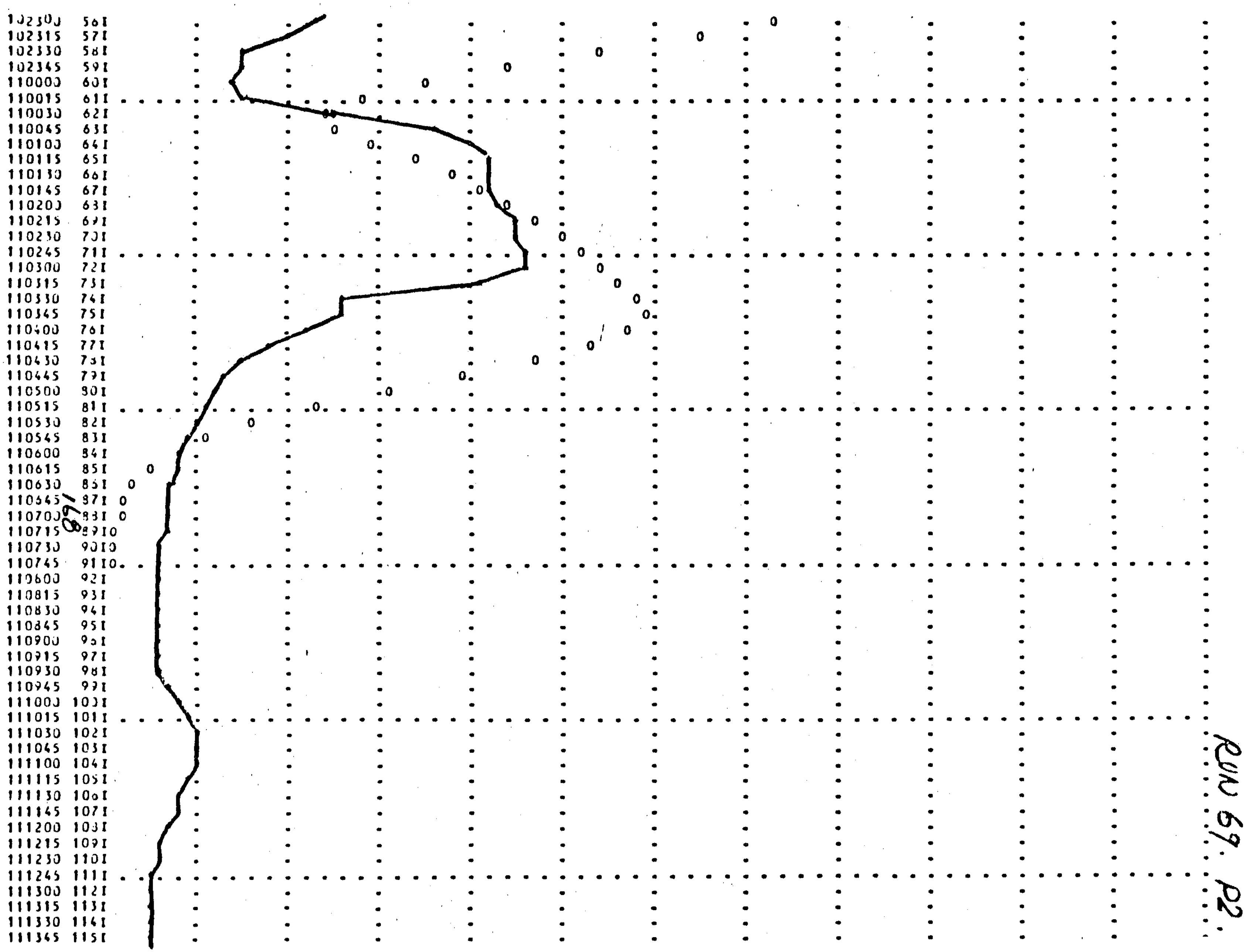
Standard Error: 149

Ave. Abs. Error: 104

Ave. % Abs. Error: 151.57%

Compare with RUN 61

RUN 67, P1


102300 56I
102315 57I
102330 58I
102345 59I
110000 60I
110015 61I
110030 62I
110045 63I
110100 64I
110115 65I
110130 66I
110145 67I
110200 68I
110215 69I
110230 70I
110245 71I
110300 72I
110315 73I
110330 74I
110345 75I
110400 76I
110415 77I
110430 78I
110445 79I
110500 80I
110515 81I
110530 82I
110545 83I
110600 84I
110615 85I
110630 86I
110645 87I
110700 88I
110715 89I0
110730 90I0
110745 91I0
110800 92I
110815 93I
110830 94I
110845 95I
110900 96I
110915 97I
110930 98I
110945 99I
111000 100I
111015 101I
111030 102I
111045 103I
111100 104I
111115 105I
111130 106I
111145 107I
111200 108I
111215 109I
111230 110I
111245 111I
111300 112I
111315 113I
111330 114I
111345 115I

168

RUN 69. P2.

RUN 70. P

STORM #1 (THEISSEN)

	Sum of Flows	mean Flow	Time to C.M.	Peak Flow	Peak Time.
Computed	29806	373	7.63	1189	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	2436	30	0.39	40	1.25.
%.	8.90%			3.49%	

Standard Error: 241

Ave. Abs. Error: 161

Ave. % Abs. Error: 60.90%

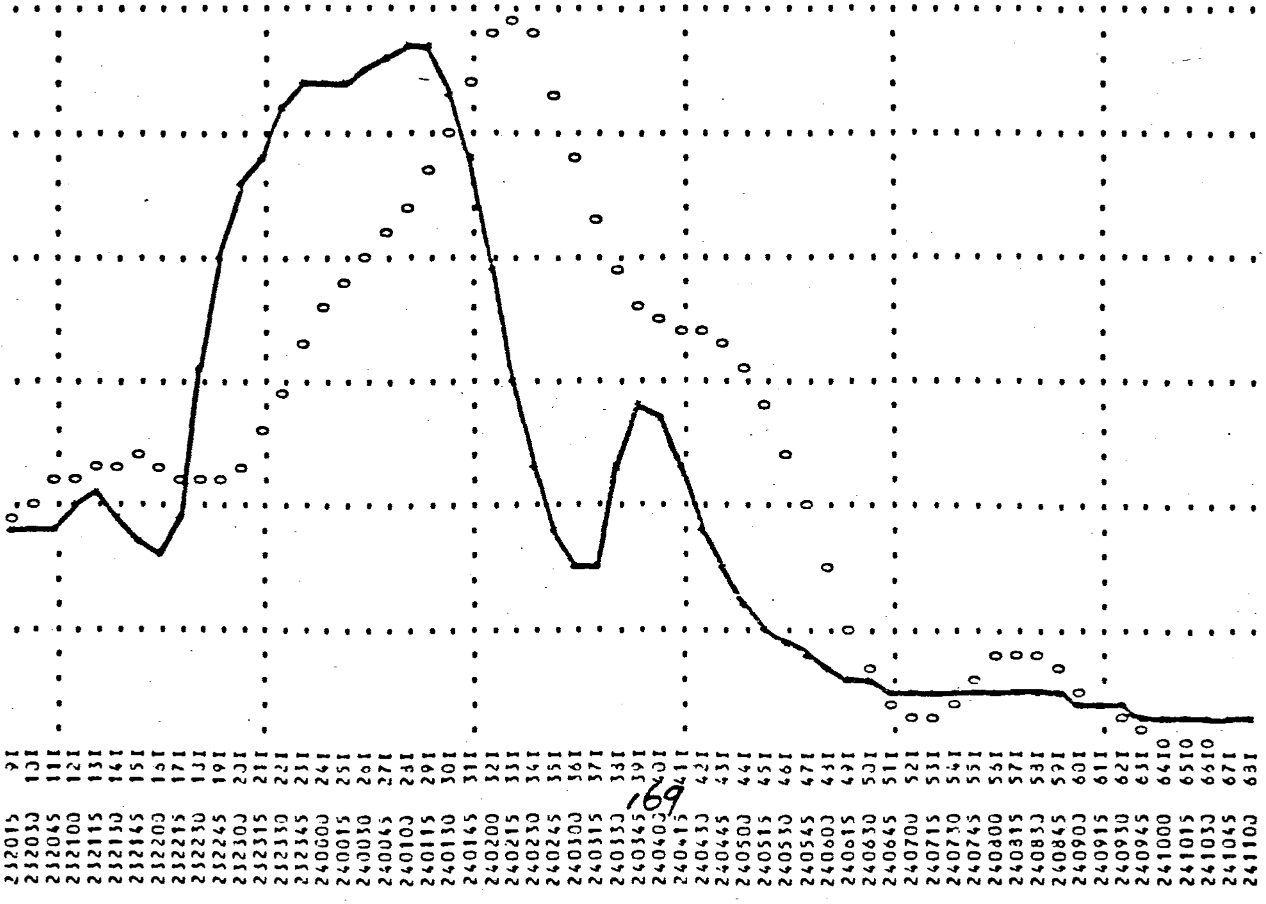
Idea: Reduce the Tc of each subarea by 50% to see if the peak moves.

from RUN #70, 71 → storm #1.

RUN 72, 73 → storm #2.

RUN 74, 75 → storm #5.

Compare this run with Run #54.

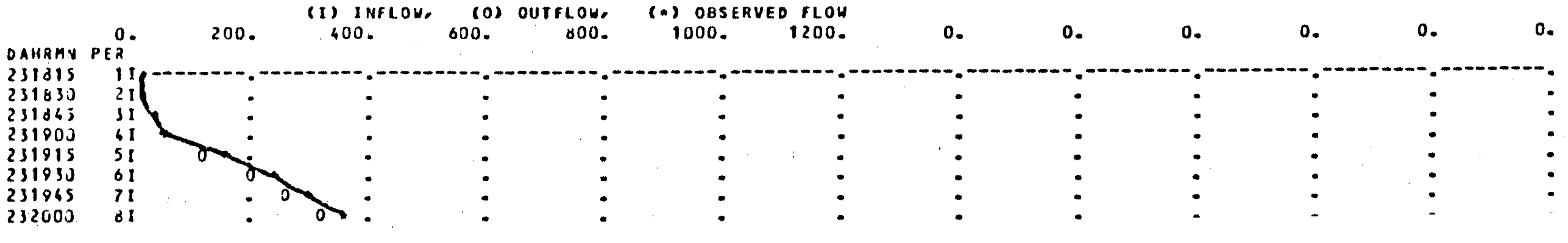


```
 *     OHSERVED HYDROGRAPH           27370.      1.085          342.      7.25        7.25        1149.       6.75       *
 *                                                                                                                     *
 *     DIFFERENCE                     2436.      0.097           30.      0.39        0.39          40.       1.25       *
 *     PERCENT DIFFERENCE              8.90                                           5.34         3.49                  *
 *                                                                                                                     *
 *                     STANDARD ERROR     241.                  AVERAGE ABSOLUTE ERROR     161.                         *
 *                 OBJECTIVE FUNCTION     280.          AVERAGE PERCENT ABSOLUTE ERROR     60.90                        *
 *                                                                                                                     *
 ***********************************************************************************************************************

****************************************************************************************************************************

                                              HYDROGRAPH AT STATION      051

****************************************************************************************************************************
                                               *                                               *
 DA MON HRMN ORD    COMP Q   OBS Q  RESIDUL    * DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL   * DA MON HRMN ORD    COMP Q   OBS Q  RESIDUL
                                               *                                               *
 23 JAN 1815   1      21.     22.      -1.     * 24 JAN 0100  28      883.    1149.    -266.   * 24 JAN 0745  55      121.    107.      14.
 23 JAN 1830   2      22.     22.       0.     * 24 JAN 0115  29      931.    1134.    -203.   * 24 JAN 0800  56      154.    107.      47.
 23 JAN 1845   3      34.     32.       2.     * 24 JAN 0130  30      997.    1067.     -70.   * 24 JAN 0815  57      170.    102.      68.
 23 JAN 1900   4      70.     57.      13.     * 24 JAN 0145  31     1081.     964.     117.   * 24 JAN 0830  58      162.     90.      72.
 23 JAN 1915   5     127.    150.     -23.     * 24 JAN 0200  32     1158.     772.     386.   * 24 JAN 0845  59      137.     90.      47.
 23 JAN 1930   6     193.    234.     -36.     * 24 JAN 0215  33     1199.     608.     581.   * 24 JAN 0900  60      105.     81.      24.
 23 JAN 1945   7     269.    299.     -30.     * 24 JAN 0230  34     1151.     469.     682.   * 24 JAN 0915  61       77.     81.      -4.
 23 JAN 2000   8     328.    355.     -27.     * 24 JAN 0245  35     1061.     365.     696.   * 24 JAN 0930  62       54.     77.     -23.
 23 JAN 2015   9     375.    359.      16.     * 24 JAN 0300  36      956.     301.     655.   * 24 JAN 0945  63       37.     67.     -30.
 23 JAN 2030  10     410.    352.      58.     * 24 JAN 0315  37      861.     301.     560.   * 24 JAN 1000  64       25.     67.     -42.
 23 JAN 2045  11     433.    369.      64.     * 24 JAN 0330  38      785.     460.     325.   * 24 JAN 1015  65       17.     67.     -50.
 23 JAN 2100  12     448.    405.      43.     * 24 JAN 0345  39      728.     567.     161.   * 24 JAN 1030  66       11.     65.     -54.
 23 JAN 2115  13     453.    414.      44.     * 24 JAN 0400  40      691.     538.     153.   * 24 JAN 1045  67        7.     61.     -54.
 23 JAN 2130  14     469.    384.      85.     * 24 JAN 0415  41      674.     458.     216.   * 24 JAN 1100  68        5.     59.     -54.
 23 JAN 2145  15     476.    331.     145.     * 24 JAN 0430  42      671.     365.     306.   * 24 JAN 1115  69        3.     59.     -56.
 23 JAN 2200  16     470.    312.     158.     * 24 JAN 0445  43      655.     299.     356.   * 24 JAN 1130  70        2.     59.     -57.
 23 JAN 2215  17     443.    383.      60.     * 24 JAN 0500  44      619.     245.     374.   * 24 JAN 1145  71        1.     57.     -56.
 23 JAN 2230  18     432.    629.    -197.     * 24 JAN 0515  45      554.     202.     352.   * 24 JAN 1200  72        1.     55.     -54.
 23 JAN 2245  19     435.    797.    -362.     * 24 JAN 0530  46      479.     175.     304.   * 24 JAN 1215  73        1.     55.     -54.
 23 JAN 2300  20     468.    912.    -444.     * 24 JAN 0545  47      391.     151.     240.   * 24 JAN 1230  74        0.     51.     -51.
 23 JAN 2315  21     522.    969.    -447.     * 24 JAN 0600  48      293.     136.     157.   * 24 JAN 1245  75        0.     51.     -51.
 23 JAN 2330  22     587.   1034.    -447.     * 24 JAN 0615  49      199.     116.      33.   * 24 JAN 1300  76        0.     51.     -51.
 23 JAN 2345  23     653.   1070.    -417.     * 24 JAN 0630  50      131.     116.      15.   * 24 JAN 1315  77        0.     49.     -49.
 24 JAN 0000  24     712.   1074.    -362.     * 24 JAN 0645  51       88.     108.     -20.   * 24 JAN 1330  78        0.     49.     -49.
 24 JAN 0015  25     761.   1072.    -311.     * 24 JAN 0700  52       66.     101.     -35.   * 24 JAN 1345  79        0.     46.     -46.
 24 JAN 0030  26     804.   1093.    -289.     * 24 JAN 0715  53       67.      99.     -32.   * 24 JAN 1400  80        0.     40.     -40.
 24 JAN 0045  27     843.   1127.    -284.     * 24 JAN 0730  54       87.      99.     -12.   *
                                               *                                               *
****************************************************************************************************************************
1                                                        STATION       051
```



```
                             (I) INFLOW,   (O) OUTFLOW,   (*) OBSERVED FLOW
          0.       200.      400.      600.      800.     1000.     1200.        0.        0.        0.        0.        0.        0.
DAHRMN PER
231815   1I---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
231830   2I         .         .         .         .         .         .         .         .         .         .         .         .
231845   3I         .         .         .         .         .         .         .         .         .         .         .         .
231900   4I         .         .         .         .         .         .         .         .         .         .         .         .
231915   5I    O    .         .         .         .         .         .         .         .         .         .         .         .
231930   6I         O         .         .         .         .         .         .         .         .         .         .         .
231945   7I         .  O      .         .         .         .         .         .         .         .         .         .         .
232000   8I         .      O  .         .         .         .         .         .         .         .         .         .         .
```

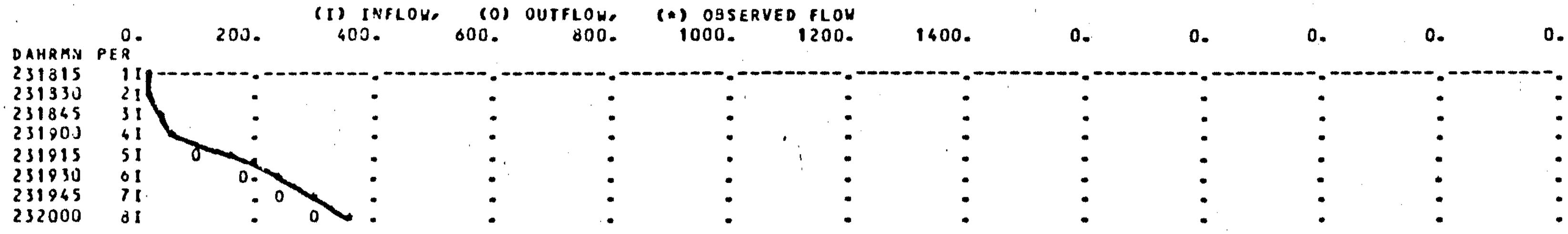
RUN 70

```
 *     OBSERVED HYDROGRAPH            27370.      1.085              342.       7.25          7.25          1149.       6.75      *
 *                                                                                                                              *
 *     DIFFERENCE                     -1091.     -0.043              -14.       0.00          0.00            94.       1.00      *
 *     PERCENT DIFFERENCE               -3.99                                                -0.06           8.21                 *
 *                                                                                                                              *
 *                        STANDARD ERROR        209.                    AVERAGE ABSOLUTE ERROR       125.                          *
 *                    OBJECTIVE FUNCTION        253.            AVERAGE PERCENT ABSOLUTE ERROR      48.22                          *
 *                                                                                                                              *
 ********************************************************************************************************************************

*************************************************************************************************************************************

                                                         HYDROGRAPH AT STATION      051

*************************************************************************************************************************************
                                                 *                                                *
 DA MON HRMN ORD     COMP Q    OBS Q   RESIDUL  * DA MON HRMN ORD     COMP Q    OBS Q   RESIDUL  * DA MON HRMN ORD     COMP Q    OBS Q   RESIDUL
                                                 *                                                *
 23 JAN 1815   1       21.       22.       -1.  * 24 JAN 0100  28       996.    1149.     -153.  * 24 JAN 0745  55        83.     107.      -24.
 23 JAN 1830   2       21.       22.       -1.  * 24 JAN 0115  29      1051.    1134.      -73.  * 24 JAN 0800  56       113.     107.        6.
 23 JAN 1845   3       30.       32.       -2.  * 24 JAN 0130  30      1124.    1067.       57.  * 24 JAN 0815  57       130.     102.       28.
 23 JAN 1900   4       59.       57.        2.  * 24 JAN 0145  31      1191.     964.      227.  * 24 JAN 0830  58       128.      90.       38.
 23 JAN 1915   5      107.      150.      -43.  * 24 JAN 0200  32      1243.     772.      471.  * 24 JAN 0845  59       110.      90.       20.
 23 JAN 1930   6      172.      234.      -62.  * 24 JAN 0215  33      1239.     608.      631.  * 24 JAN 0900  60        86.      81.        5.
 23 JAN 1945   7      238.      299.      -61.  * 24 JAN 0230  34      1152.     469.      683.  * 24 JAN 0915  61        63.      81.      -18.
 23 JAN 2000   8      293.      355.      -62.  * 24 JAN 0245  35      1002.     365.      637.  * 24 JAN 0930  62        45.      77.      -32.
 23 JAN 2015   9      333.      359.      -21.  * 24 JAN 0300  36       837.     301.      536.  * 24 JAN 0945  63        31.      67.      -36.
 23 JAN 2030  10      371.      352.       19.  * 24 JAN 0315  37       696.     301.      395.  * 24 JAN 1000  64        21.      67.      -46.
 23 JAN 2045  11      394.      369.       25.  * 24 JAN 0330  38       591.     460.      131.  * 24 JAN 1015  65        14.      67.      -53.
 23 JAN 2100  12      409.      405.        4.  * 24 JAN 0345  39       519.     567.      -48.  * 24 JAN 1030  66         9.      65.      -56.
 23 JAN 2115  13      413.      414.        4.  * 24 JAN 0400  40       475.     538.      -63.  * 24 JAN 1045  67         6.      61.      -55.
 23 JAN 2130  14      420.      384.       36.  * 24 JAN 0415  41       448.     458.      -10.  * 24 JAN 1100  68         4.      59.      -55.
 23 JAN 2145  15      418.      331.       87.  * 24 JAN 0430  42       427.     365.       62.  * 24 JAN 1115  69         3.      59.      -56.
 23 JAN 2200  16      410.      312.       98.  * 24 JAN 0445  43       388.     299.       89.  * 24 JAN 1130  70         2.      59.      -57.
 23 JAN 2215  17      398.      338.       10.  * 24 JAN 0500  44       333.     245.       88.  * 24 JAN 1145  71         1.      57.      -56.
 23 JAN 2230  18      393.      629.     -231.  * 24 JAN 0515  45       256.     202.       54.  * 24 JAN 1200  72         1.      55.      -54.
 23 JAN 2245  19      411.      797.     -336.  * 24 JAN 0530  46       182.     175.        7.  * 24 JAN 1215  73         0.      55.      -55.
 23 JAN 2300  20      443.      912.     -469.  * 24 JAN 0545  47       124.     151.      -27.  * 24 JAN 1230  74         0.      51.      -51.
 23 JAN 2315  21      495.      969.     -473.  * 24 JAN 0600  48        84.     136.      -52.  * 24 JAN 1245  75         0.      51.      -51.
 23 JAN 2330  22      571.     1034.     -463.  * 24 JAN 0615  49        56.     116.      -60.  * 24 JAN 1300  76         0.      51.      -51.
 23 JAN 2345  23      659.     1070.     -411.  * 24 JAN 0630  50        38.     116.      -78.  * 24 JAN 1315  77         0.      49.      -49.
 24 JAN 0000  24      738.     1074.     -336.  * 24 JAN 0645  51        25.     108.      -83.  * 24 JAN 1330  78         0.      49.      -49.
 24 JAN 0015  25      802.     1072.     -270.  * 24 JAN 0700  52        22.     101.      -79.  * 24 JAN 1345  79         0.      46.      -46.
 24 JAN 0030  26      863.     1093.     -230.  * 24 JAN 0715  53        33.      99.      -66.  * 24 JAN 1400  80         0.      40.      -40.
 24 JAN 0045  27      923.     1127.     -199.  * 24 JAN 0730  54        54.      99.      -45.  *
                                                 *                                                *
*************************************************************************************************************************************
1                                                                      STATION      051
```



```
                                 (I) INFLOW,   (O) OUTFLOW,   (*) OBSERVED FLOW
          0.      200.      400.      600.      800.     1000.     1200.     1400.        0.        0.        0.        0.        0.
DAHRMN PER
231815   1I---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.---------.
231830   2I         .         .         .         .         .         .         .         .         .         .         .         .
231845   3I         .         .         .         .         .         .         .         .         .         .         .         .
231900   4I         .         .         .         .         .         .         .         .         .         .         .         .
231915   5I   0     .         .         .         .         .         .         .         .         .         .         .         .
231930   6I        0.         .         .         .         .         .         .         .         .         .         .         .
231945   7I         . 0       .         .         .         .         .         .         .         .         .         .         .
232000   8I         .    0    .         .         .         .         .         .         .         .         .         .         .
```

Run 71 P1

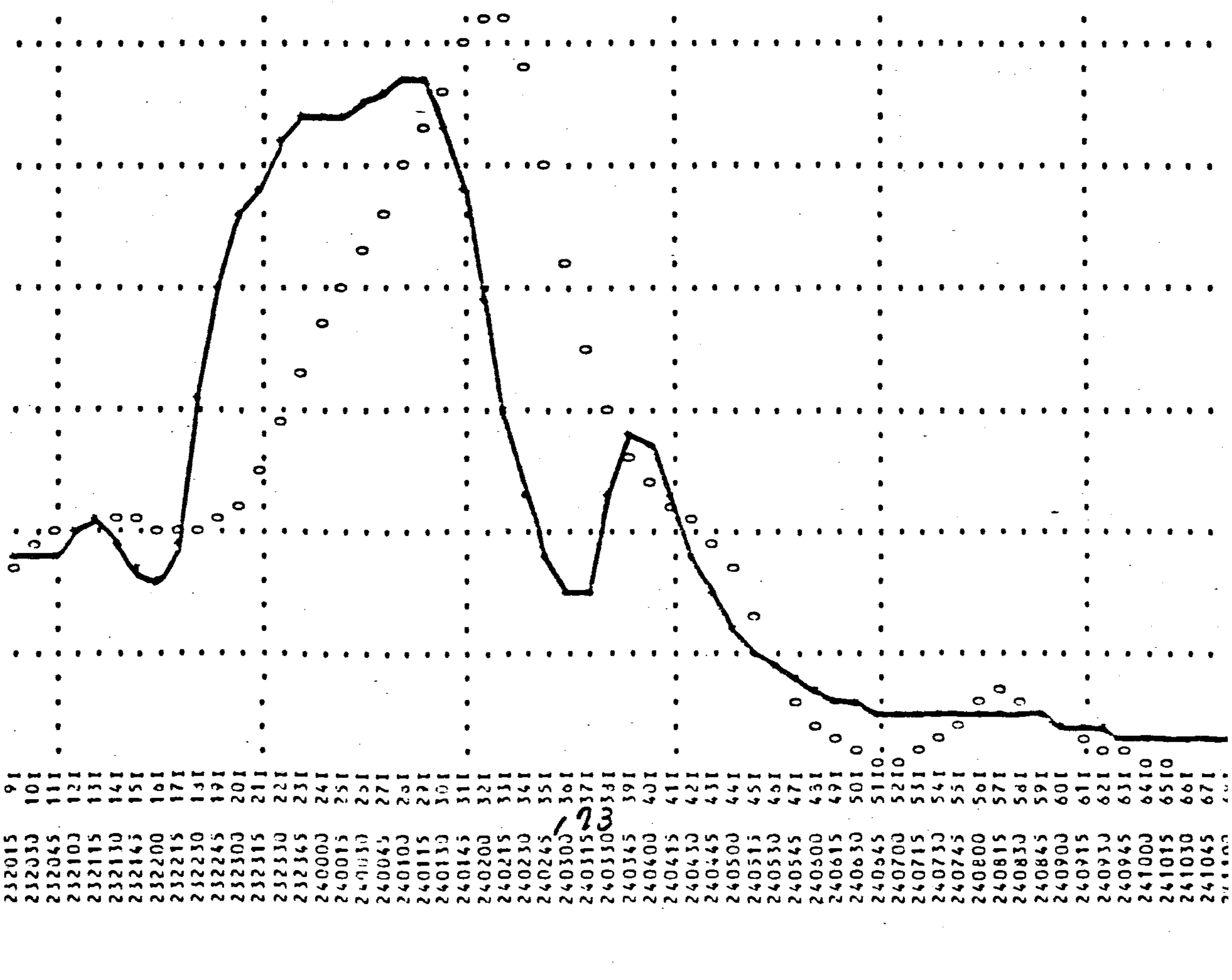
RUN 71. P2.

STORM #1 (ISOHYETAL)

	Sum of Flows	mean Flow	time to C.M.	peak Flow	peak Time
Computed	26279	328	7.24	1243	7.75
observed	27370	342	7.25	1149	6.75
Diff.	−1091	−14	0.00	94	1.00
%.	−3.99%			8.21%	

Standard Error: 209
Ave. Abs. Error: 125
Ave. % Abs. Error 48.22%.

Compare with run 55.



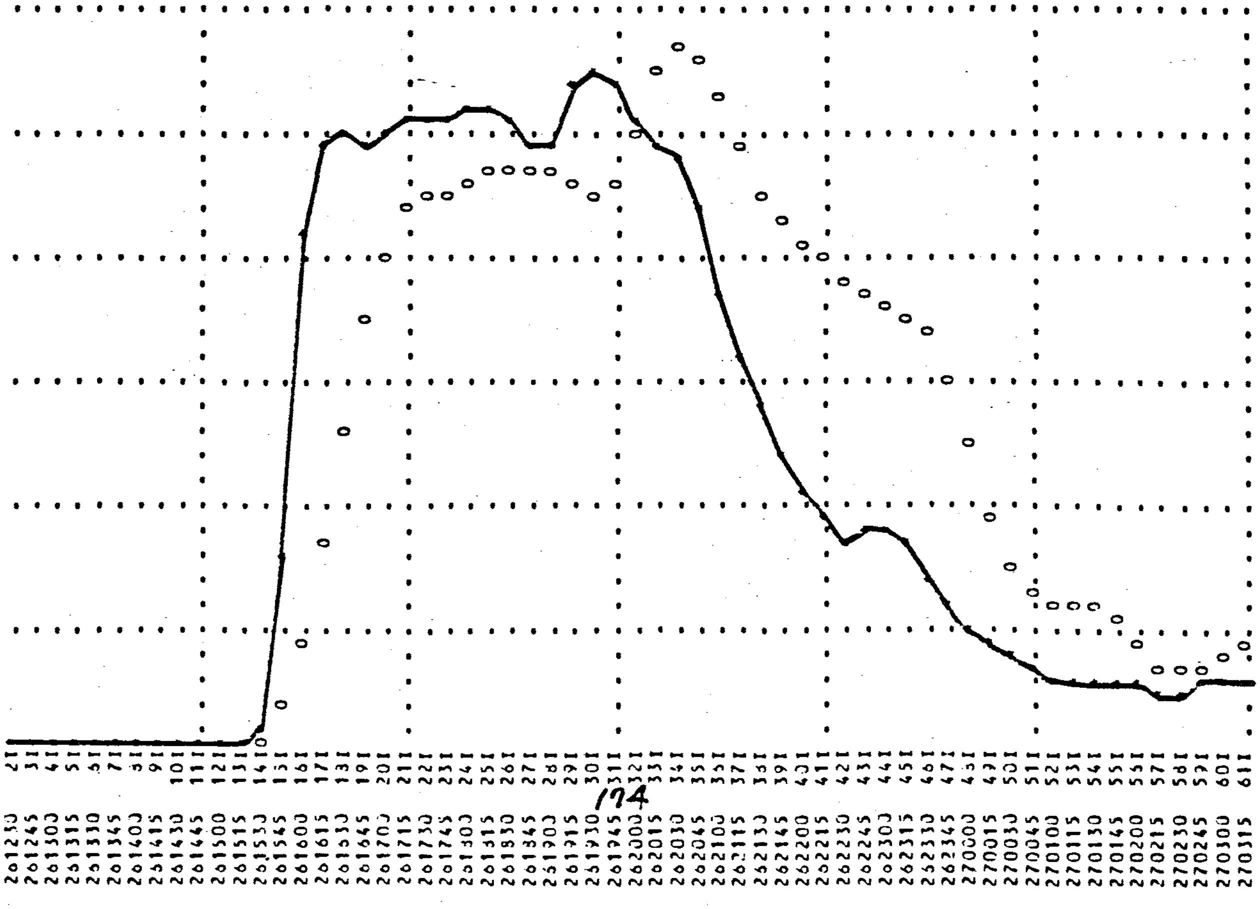
RUN 72 . P1

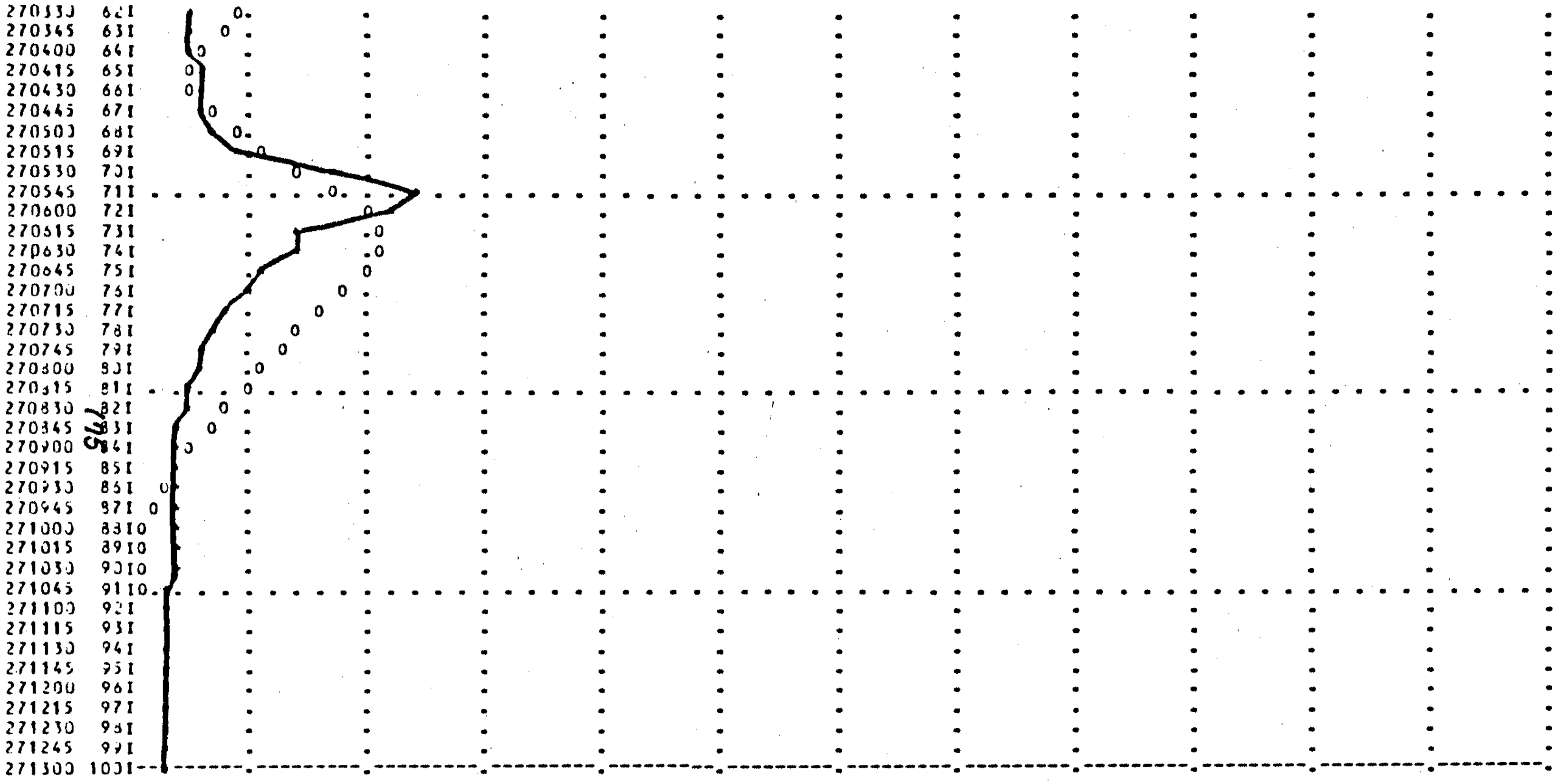
STORM #2 (THEISSEN)

	Sum of Flows	mean Flow	Time to C.M.	peak flow	peak Time
computed	35950	.359	10.13	1144	8.25
observed	32721	.327	9.36	1099	7.25
Diff.	3229	32	0.78	45	1.00
%	9.87%			4.05%	

Standard Error: 192
Ave. Obs. Error: 131
Ave. % Obs Error: 58.72%

Compare with Run 56





Run 72. P2.

```
1
1
                                          RUNOFF SUMMARY
                                    FLOW IN CUBIC FEET PER SECOND
                                 TIME IN HOURS,  AREA IN SQUARE MILES

                                  PEAK   TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN   MAXIMUM   TIME OF
         OPERATION      STATION   FLOW    PEAK                                           AREA    STAGE    MAX STAGE
+                                                  6-HOUR      24-HOUR      72-HOUR

         HYDROGRAPH AT
+                         00A      614.   7.00       253.         90.          87.       2.98

         ROUTED TO
+                        1T02      508.   7.50       250.         90.          87.       2.98

         HYDROGRAPH AT
+                         00B      168.   3.50        90.         31.          30.       0.38

         HYDROGRAPH AT
```

RUN 73 P1

STORM #2 (ISOHYETAL).

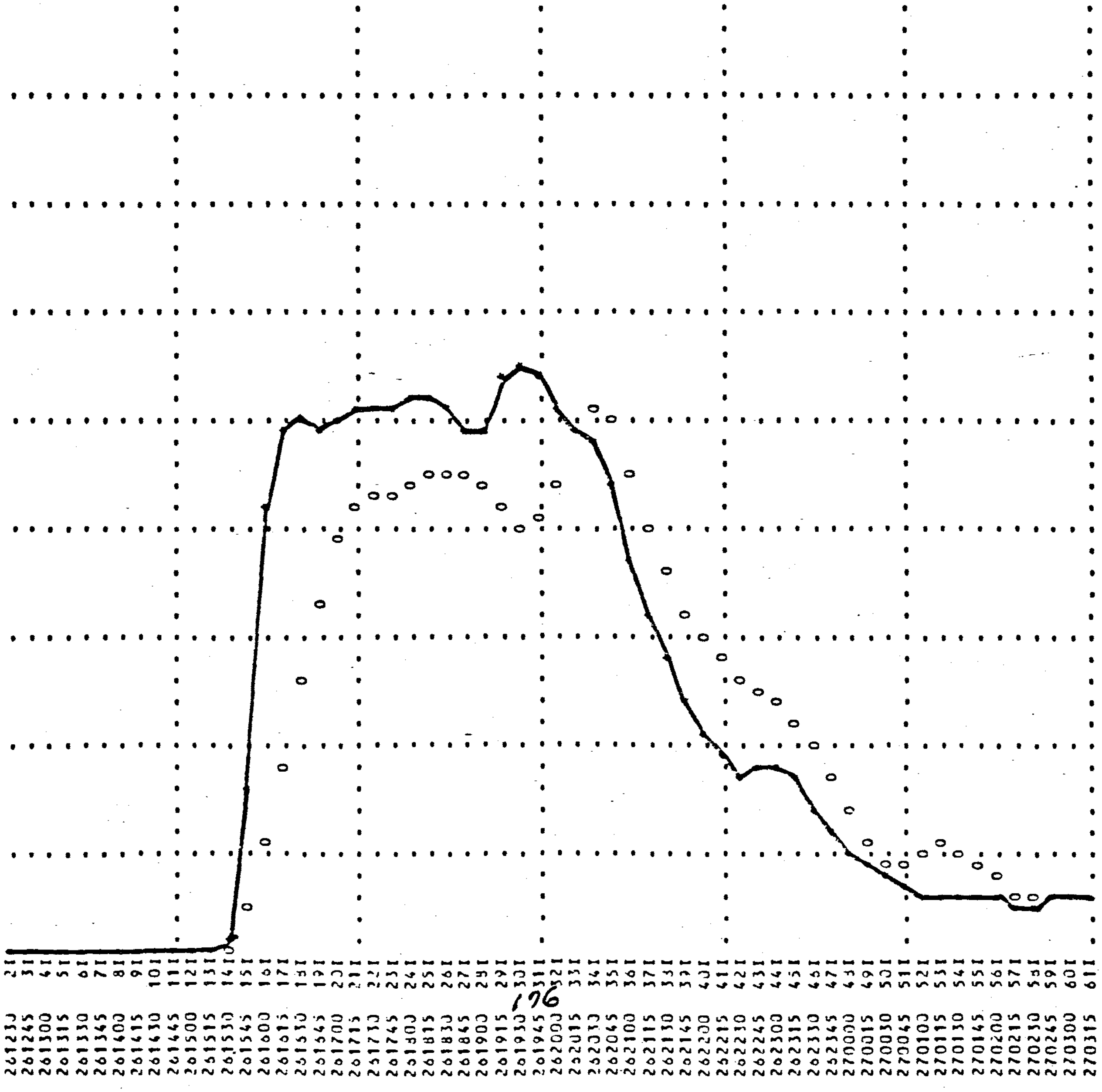
	Sum of Flows	mean Flow	Time to C.M.	peak Flow	peak Time
Computed	30151	302	9.78	1022	8.25
observed	32721	327	9.36	1099	7.25
Diff.	-2570	-26	0.42	-77	1.00
%	-7.86			-7.01%	

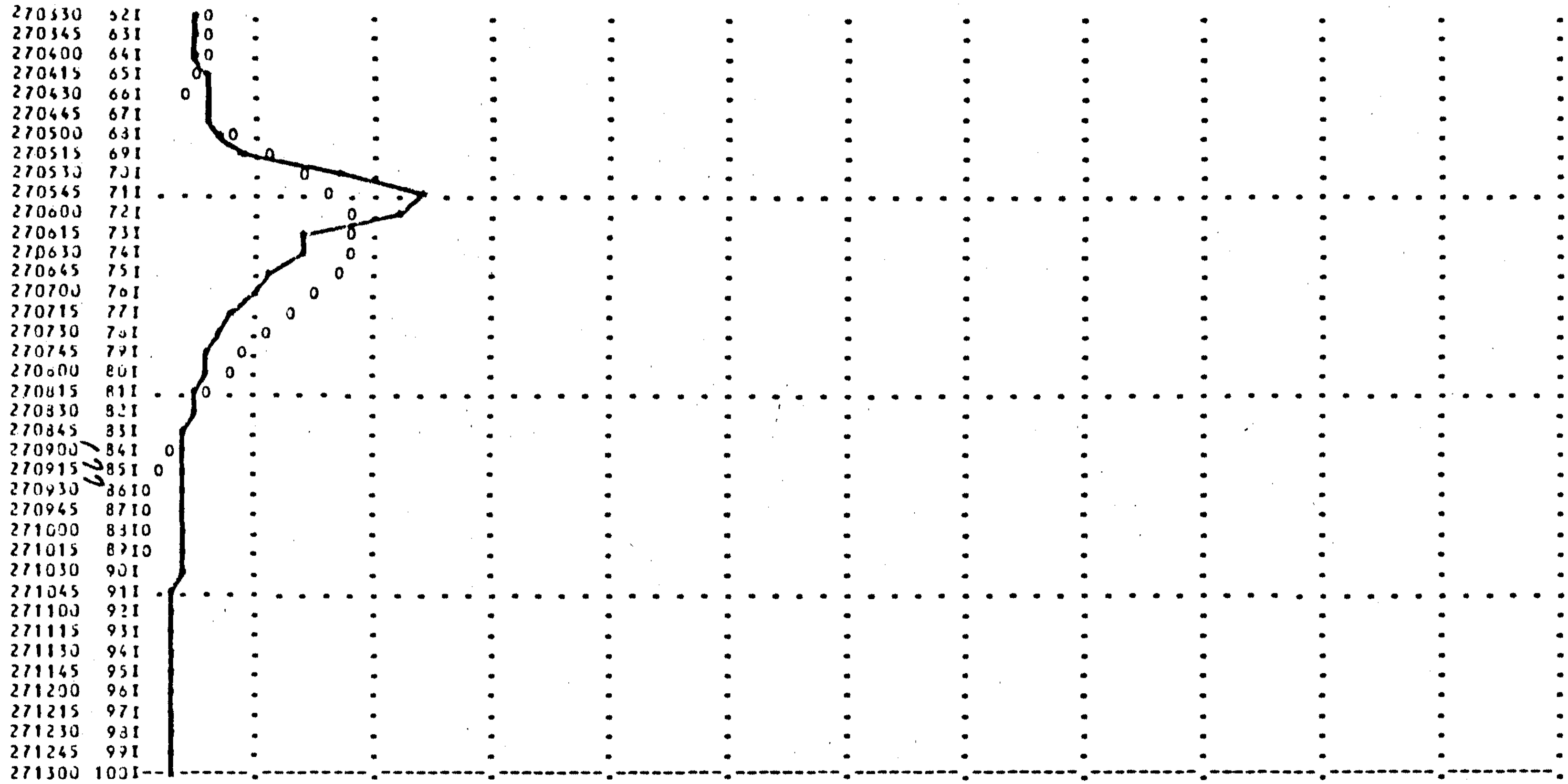
Standard Error: 143

Ave. Abs. Error: 92

Ave. % Abs. Error: 41.44%.

Compare with Run 57





Run 73.P2

```
1
1
                                        RUNOFF SUMMARY
                                 FLOW IN CUBIC FEET PER SECOND
                             TIME IN HOURS,  AREA IN SQUARE MILES

                                         PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN     MAXIMUM     TIME OF
          OPERATION          STATION     FLOW     PEAK                                                AREA      STAGE     MAX STAGE
+                                                               6-HOUR       24-HOUR      72-HOUR

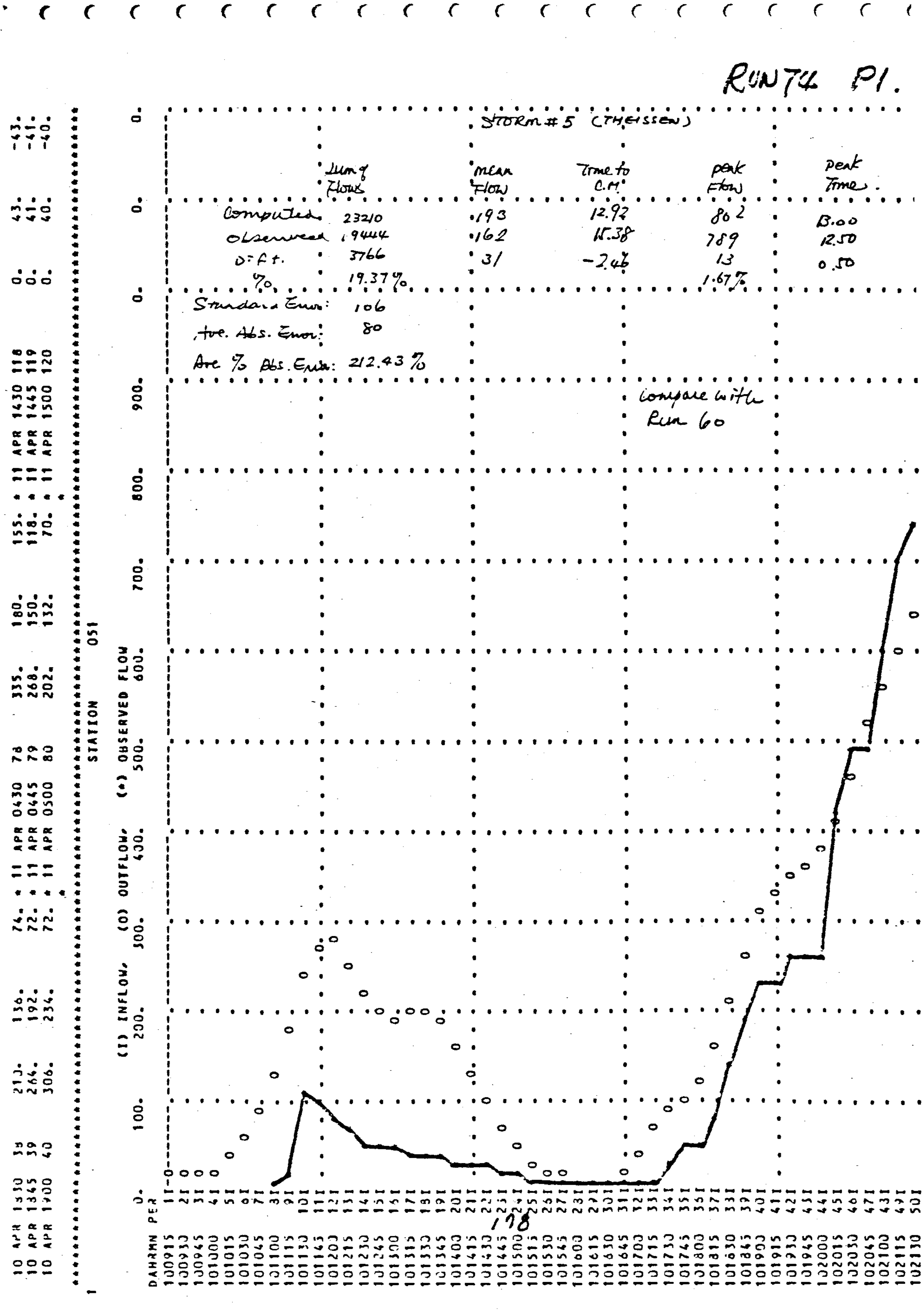
          HYDROGRAPH AT
+                              00A       645.     7.00          249.          74.          71.         2.98

          ROUTED TO
+                             1T02       531.     7.50          248.          74.          71.         2.98

          HYDROGRAPH AT
+                              00B       144.     3.50           78.          28.          27.         0.38

          HYDROGRAPH AT
+
```

RUN74 P1.



STORM # 5 (THEISSEN)

	Sum of Flows	mean Flow	Time to C.M.	peak Flow	peak Time.
Computed	23210	.193	12.92	802	13.00
observed	19444	.162	15.38	789	12.50
Diff.	3766	31	-2.46	13	0.50
%	19.37%			1.67%	

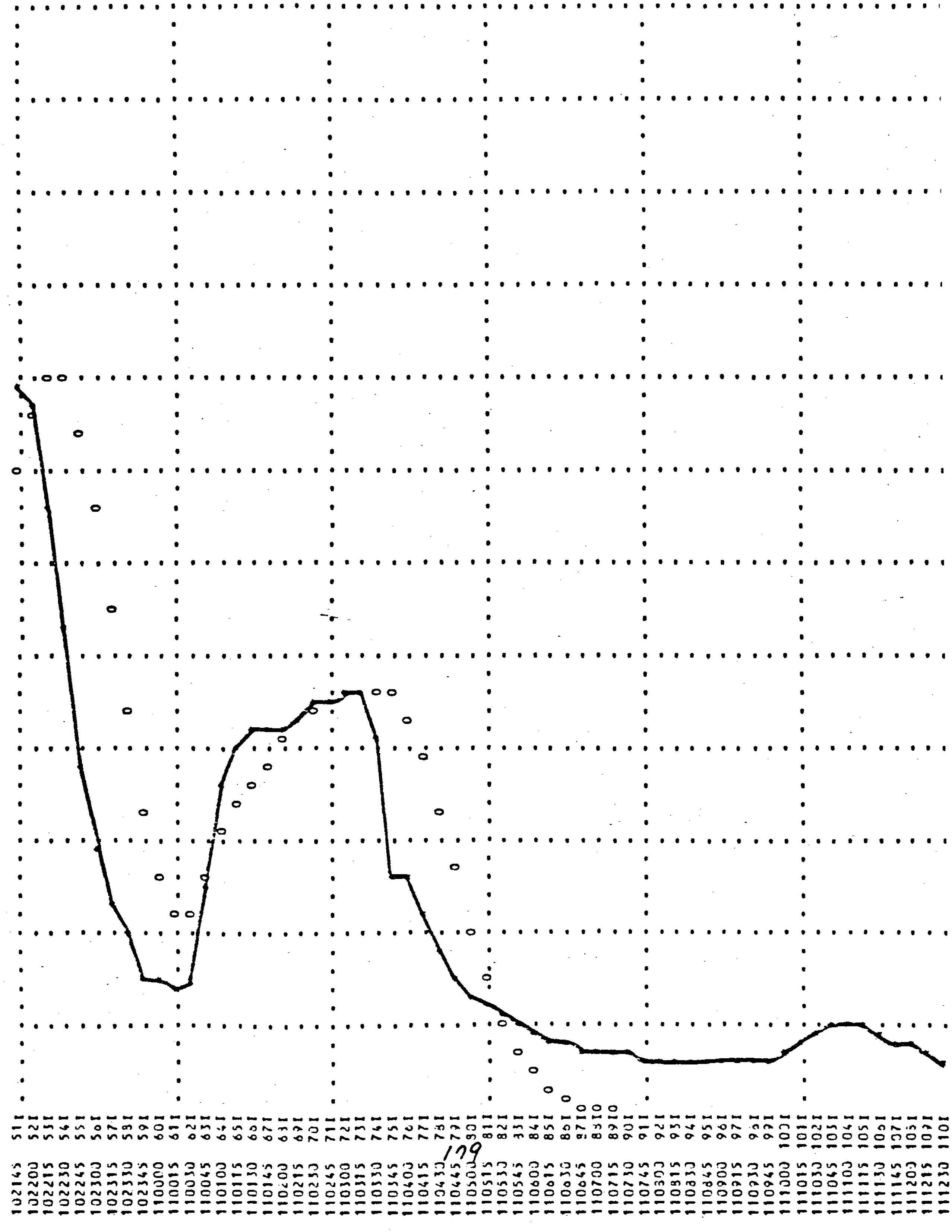
Standard Error: 106

Ave. Abs. Error: 80

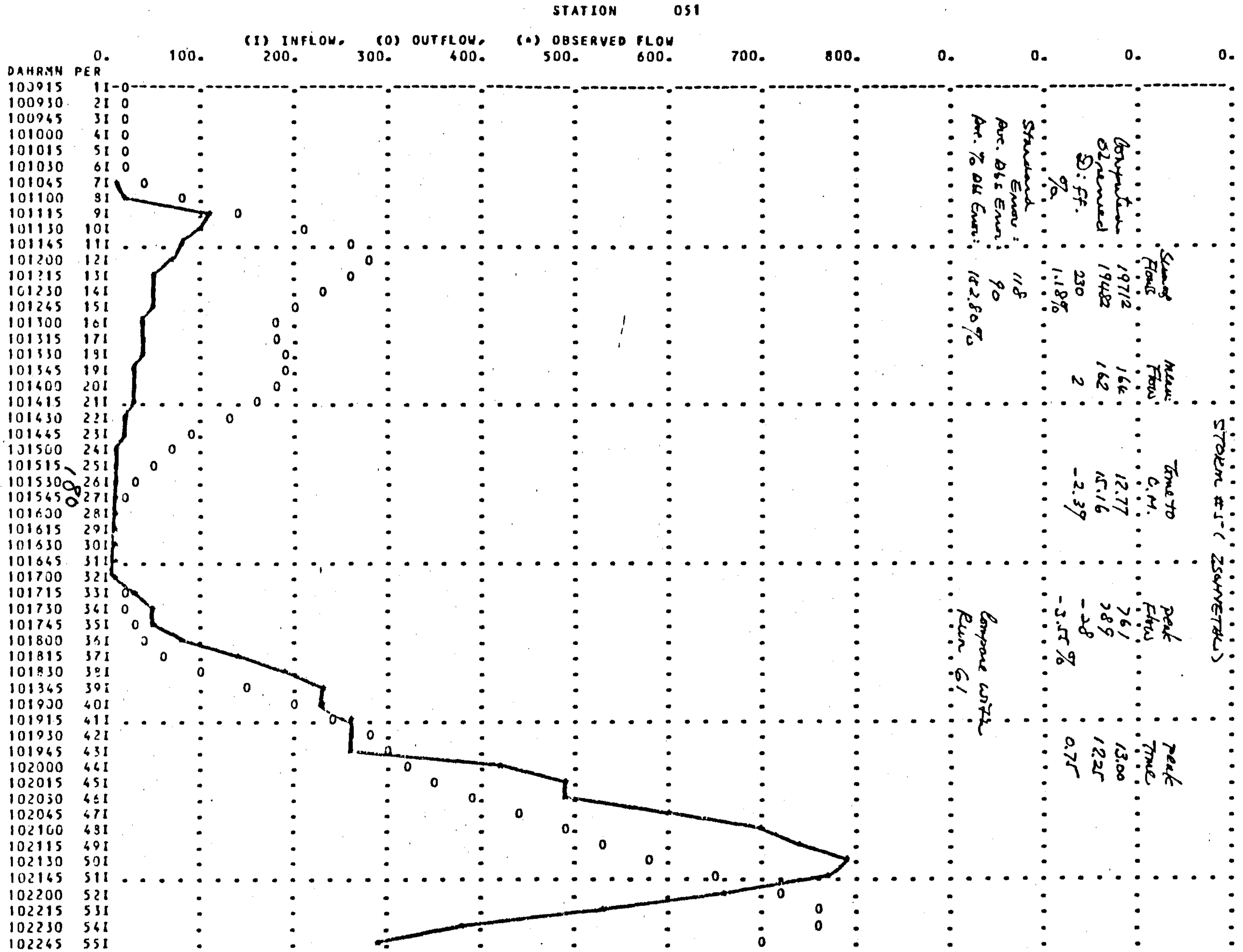
Ave % Abs. Error: 212.43%

compare with Run 60

RUN 74. P2.


102145 51
102200 52
102215 53
102230 54
102245 55
102300 56
102315 57
102330 58
102345 59
110000 60
110015 61
110030 62
110045 63
110100 64
110115 65
110130 66
110145 67
110200 68
110215 69
110230 70
110245 71
110300 72
110315 73
110330 74
110345 75
110400 76
110415 77
110430 78
110445 79
110500 80
110515 81
110530 82
110545 83
110600 84
110615 85
110630 86
110645 87
110700 88
110715 89
110730 90
110745 91
110800 92
110815 93
110830 94
110845 95
110900 96
110915 97
110930 98
110945 99
111000 100
111015 101
111030 102
111045 103
111100 104
111115 105
111130 106
111145 107
111200 108
111215 109
111230 110

RUN 7.5 P1



180

STORM #5 (ZSCHNETAL)

	Sum of Flows	Mean Flow	Time to C.M.	peak Flow	peak Time
Computed	19712	166	12.77	761	13.00
Observed	19482	162	15.16	789	12.25
Diff.	230	2	-2.39	-28	0.75
%	1.18%			-3.55%	

Standard Error: 118
Ave. Abs Error: 90
Ave. % Abs Error: 182.80%

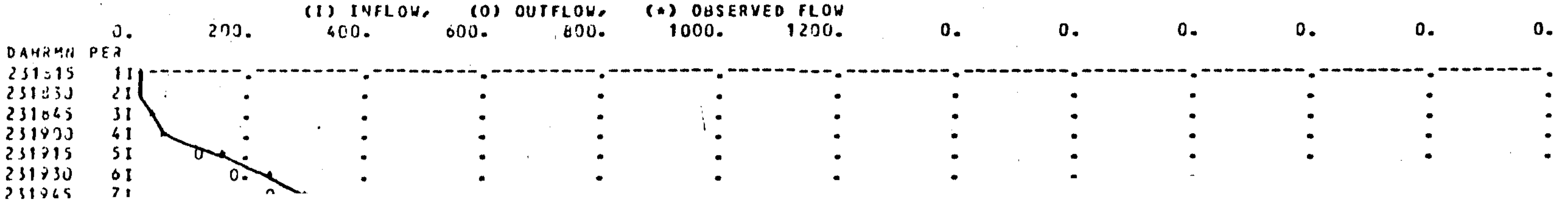
Compare with Run 61

```
  *      OBSERVED HYDROGRAPH          27370.      1.085              342.       7.25          7.25          1149.       6.75         *
  *                                                                                                                                  *
  *      DIFFERENCE                    1632.      0.065               20.       0.39          0.39            10.       1.25         *
  *      PERCENT DIFFERENCE               5.96                                                5.38           0.89                    *
  *                                                                                                                                  *
  *                     STANDARD ERROR      247.                    AVERAGE ABSOLUTE ERROR          164.                             *
  *                 OBJECTIVE FUNCTION      290.            AVERAGE PERCENT ABSOLUTE ERROR          59.97                            *
  *                                                                                                                                  *
  ****************************************************************************************************************************************

*****************************************************************************************************************************************

                                                              HYDROGRAPH AT STATION       051

*****************************************************************************************************************************************
                                                  *                                               *
 DA MON HRMN ORD   COMP Q    OBS Q   RESIDUL * DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL * DA MON HRMN ORD    COMP Q    OBS Q   RESIDUL
                                                  *                                               *
 23 JAN 1315   1      21.      22.       -1. * 24 JAN 0100  28      844.    1149.      -305. * 24 JAN 0745  55      104.     107.       -3.
 23 JAN 1330   2      21.      22.       -1. * 24 JAN 0115  29      886.    1134.      -248. * 24 JAN 0800  56      134.     107.       27.
 23 JAN 1345   3      31.      32.       -1. * 24 JAN 0130  30      942.    1067.      -125. * 24 JAN 0815  57      152.     102.       50.
 23 JAN 1900   4      61.      57.        4. * 24 JAN 0145  31     1019.     964.        55. * 24 JAN 0830  58      149.      90.       59.
 23 JAN 1915   5     112.     150.      -38. * 24 JAN 0200  32     1103.     772.       331. * 24 JAN 0845  59      129.      90.       39.
 23 JAN 1930   6     179.     234.      -55. * 24 JAN 0215  33     1159.     608.       551. * 24 JAN 0900  60      101.      81.       20.
 23 JAN 1945   7     247.     299.      -52. * 24 JAN 0230  34     1156.     469.       687. * 24 JAN 0915  61       75.      81.       -6.
 23 JAN 2000   8     307.     355.      -48. * 24 JAN 0245  35     1093.     365.       728. * 24 JAN 0930  62       53.      77.      -24.
 23 JAN 2015   9     357.     359.       -2. * 24 JAN 0300  36      996.     301.       695. * 24 JAN 0945  63       36.      67.      -31.
 23 JAN 2030  10     396.     352.       44. * 24 JAN 0315  37      897.     301.       596. * 24 JAN 1000  64       25.      67.      -42.
 23 JAN 2045  11     425.     369.       56. * 24 JAN 0330  38      811.     460.       351. * 24 JAN 1015  65       17.      67.      -50.
 23 JAN 2100  12     442.     405.       37. * 24 JAN 0345  39      744.     567.       177. * 24 JAN 1030  66       11.      65.      -54.
 23 JAN 2115  13     455.     414.       41. * 24 JAN 0400  40      698.     538.       160. * 24 JAN 1045  67        7.      61.      -54.
 23 JAN 2130  14     465.     384.       81. * 24 JAN 0415  41      673.     458.       215. * 24 JAN 1100  68        5.      59.      -54.
 23 JAN 2145  15     473.     331.      142. * 24 JAN 0430  42      659.     365.       294. * 24 JAN 1115  69        3.      59.      -56.
 23 JAN 2200  16     468.     312.      156. * 24 JAN 0445  43      640.     299.       341. * 24 JAN 1130  70        2.      59.      -57.
 23 JAN 2215  17     446.     388.       58. * 24 JAN 0500  44      603.     245.       358. * 24 JAN 1145  71        1.      57.      -56.
 23 JAN 2230  18     427.     629.     -202. * 24 JAN 0515  45      541.     202.       339. * 24 JAN 1200  72        1.      55.      -54.
 23 JAN 2245  19     426.     797.     -371. * 24 JAN 0530  46      462.     175.       287. * 24 JAN 1215  73        1.      55.      -54.
 23 JAN 2300  20     451.     912.     -461. * 24 JAN 0545  47      363.     151.       212. * 24 JAN 1230  74        0.      51.      -51.
 23 JAN 2315  21     501.     969.     -468. * 24 JAN 0600  48      261.     136.       125. * 24 JAN 1245  75        0.      51.      -51.
 23 JAN 2330  22     559.    1034.     -475. * 24 JAN 0615  49      177.     116.        61. * 24 JAN 1300  76        0.      51.      -51.
 23 JAN 2345  23     621.    1070.     -449. * 24 JAN 0630  50      118.     116.         2. * 24 JAN 1315  77        0.      49.      -49.
 24 JAN 0000  24     679.    1074.     -395. * 24 JAN 0645  51       80.     108.       -28. * 24 JAN 1330  78        0.      49.      -49.
 24 JAN 0015  25     729.    1072.     -343. * 24 JAN 0700  52       59.     101.       -42. * 24 JAN 1345  79        0.      46.      -46.
 24 JAN 0030  26     771.    1093.     -322. * 24 JAN 0715  53       58.      99.       -41. * 24 JAN 1400  80        0.      40.      -40.
 24 JAN 0045  27     809.    1127.     -318. * 24 JAN 0730  54       75.      99.       -24. *
                                                  *                                               *
*****************************************************************************************************************************************
1                                                                    STATION       051
```



```
                                 (I) INFLOW,   (O) OUTFLOW,   (*) OBSERVED FLOW
          0.        200.       400.       600.       800.      1000.      1200.          0.         0.         0.         0.         0.         0.
DAHRMN PER
231815   1I---------.----------.----------.----------.----------.----------.----------.----------.----------.----------.----------.----------.
231830   2I          .          .          .          .          .          .          .          .          .          .          .          .
231845   3I          .          .          .          .          .          .          .          .          .          .          .          .
231900   4I          .          .          .          .          .          .          .          .          .          .          .          .
231915   5I    O  *  .          .          .          .          .          .          .          .          .          .          .          .
231930   6I        O.   *       .          .          .          .          .          .          .
231945   7I            O
```

RUN 76

Storm 1

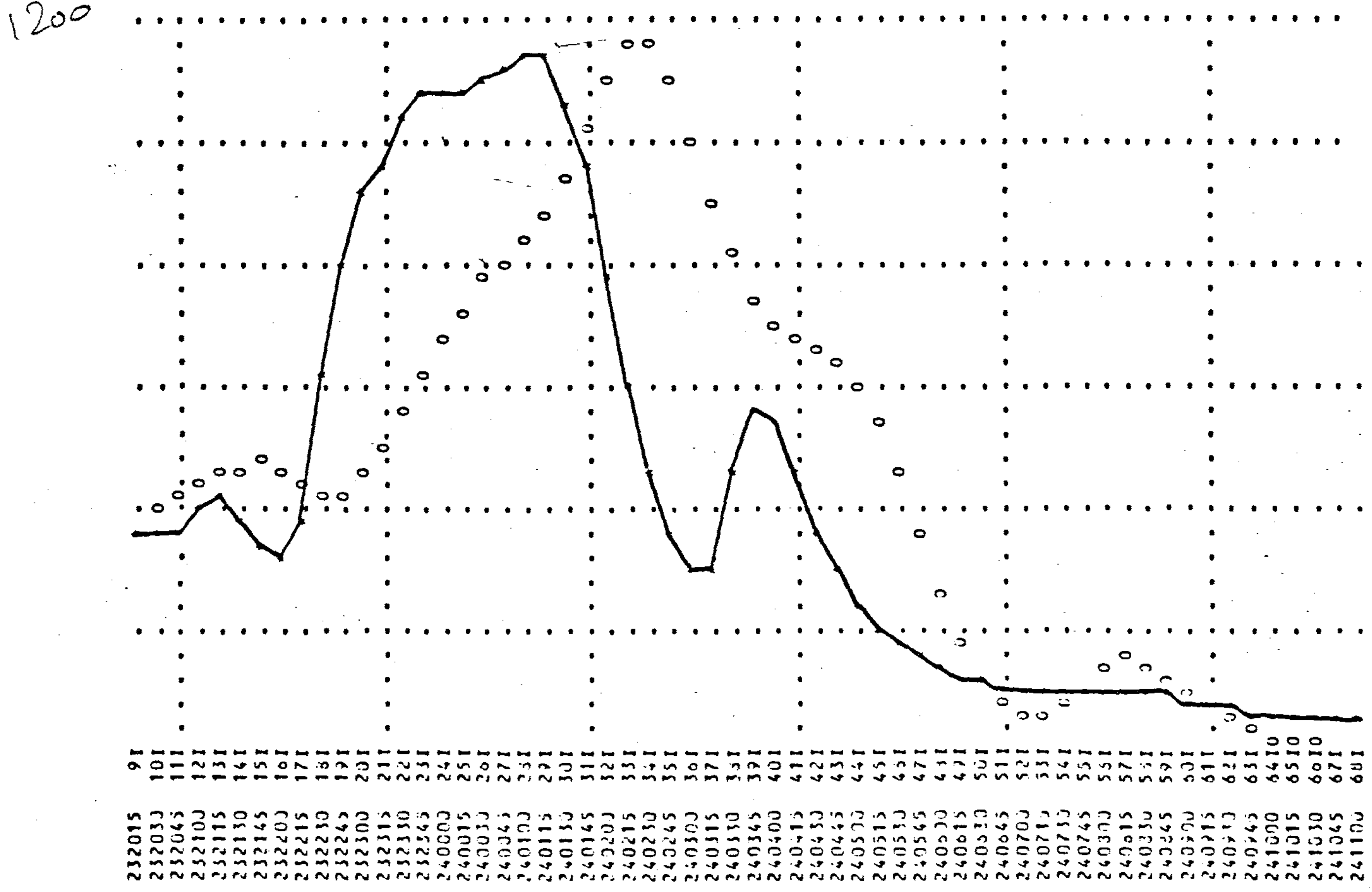
— modified DLTKR
— modified Tc.

	Sum of Flows	mean Flow	Time to C.M.	peak Flow	Time to peak
Computed	29002	363	7.64	1159	8.00
Observed	27370	342	7.25	1149	6.75
Diff.	1632	21	0.39	10	1.25
%	5.96%			0.87 %	

DLTKR: 75% for A
65% for B, H.
55% for L, M, N, I J.
(of accumulated Rainfall).

Tc: from Hathaway eq.

Standard Error: 247
Ave. Abs. Error: 164
Ave. % Abs. Error: 57.97%



Run 7

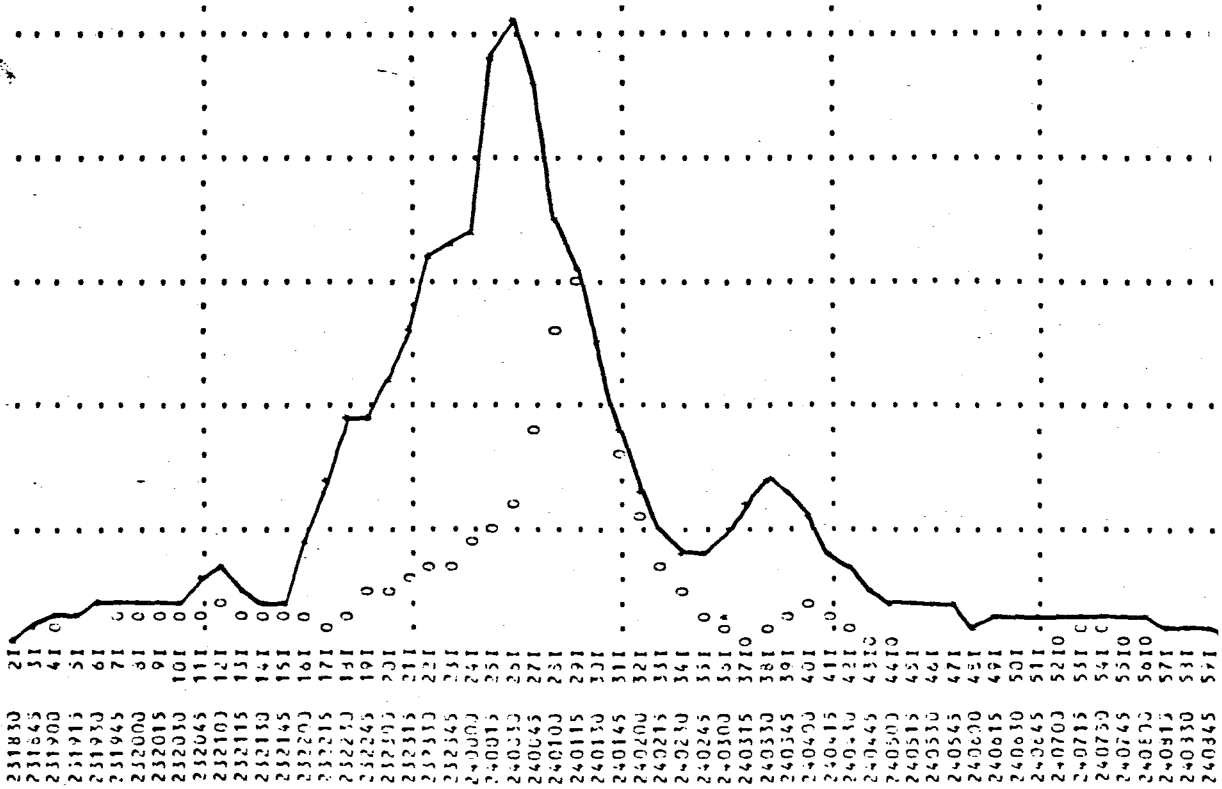
STORM 1 for Area A only

	Sum of Flow	mean Flow	Time to C.M.	peak Flow	Time of Peak
Computed	5523	69	6.56	610	7.00
Observed	14174	177	7.24	1012	6.25
Diff.	-8651	-108	-0.68	-402	0.75
%	-61.04%			-39.72%	

Standard Error: 197

Ave Abs. Error: 108

Ave. % Abs. Error: 68.29%



```
*     OBSERVED HYDROGRAPH        27370.     1.085          342.       7.25        7.25        1149.      6.75     *
*                                                                                                             *
*     DIFFERENCE                 10184.     0.404          127.       0.63        0.63         407.      0.75     *
*     PERCENT DIFFERENCE          37.21                                           8.64         35.42               *
*                                                                                                             *
*                   STANDARD ERROR      285.                 AVERAGE ABSOLUTE ERROR        180.                   *
*               OBJECTIVE FUNCTION      321.         AVERAGE PERCENT ABSOLUTE ERROR      60.36                    *
*                                                                                                             *
***************************************************************************************************************

*****************************************************************************************************************

                                          HYDROGRAPH AT STATION      051

*****************************************************************************************************************
                                                 *                                                *
DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL  * DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL  * DA MON HRMN ORD    COMP Q    OBS Q  RESIDUL
                                                 *                                                *
23 JAN 1815   1       23.      22.       1.  * 24 JAN 0100  28     1392.    1149.     243.  * 24 JAN 0745  55      157.     107.      50.
23 JAN 1830   2       23.      22.       1.  * 24 JAN 0115  29     1486.    1134.     352.  * 24 JAN 0800  56      182.     107.      75.
23 JAN 1845   3       33.      32.       1.  * 24 JAN 0130  30     1553.    1067.     486.  * 24 JAN 0815  57      192.     102.      90.
23 JAN 1900   4       64.      57.       7.  * 24 JAN 0145  31     1556.     964.     592.  * 24 JAN 0830  58      183.      90.      93.
23 JAN 1915   5      116.     150.     -34.  * 24 JAN 0200  32     1491.     772.     719.  * 24 JAN 0845  59      161.      90.      71.
23 JAN 1930   6      185.     234.     -49.  * 24 JAN 0215  33     1388.     608.     780.  * 24 JAN 0900  60      135.      81.      54.
23 JAN 1945   7      256.     299.     -43.  * 24 JAN 0230  34     1273.     469.     804.  * 24 JAN 0915  61      111.      81.      30.
23 JAN 2000   8      317.     355.     -38.  * 24 JAN 0245  35     1158.     365.     793.  * 24 JAN 0930  62       90.      77.      13.
23 JAN 2015   9      365.     357.       7.  * 24 JAN 0300  36     1049.     301.     748.  * 24 JAN 0945  63       73.      67.       6.
23 JAN 2030  10      404.     352.      52.  * 24 JAN 0315  37      954.     301.     653.  * 24 JAN 1000  64       60.      67.      -7.
23 JAN 2045  11      432.     369.      63.  * 24 JAN 0330  38      876.     460.     416.  * 24 JAN 1015  65       51.      67.     -16.
23 JAN 2100  12      452.     405.      47.  * 24 JAN 0345  39      821.     567.     254.  * 24 JAN 1030  66       45.      65.     -20.
23 JAN 2115  13      469.     414.      55.  * 24 JAN 0400  40      795.     538.     257.  * 24 JAN 1045  67       42.      61.     -19.
23 JAN 2130  14      488.     384.     104.  * 24 JAN 0415  41      803.     458.     345.  * 24 JAN 1100  68       39.      59.     -20.
23 JAN 2145  15      507.     331.     176.  * 24 JAN 0430  42      822.     365.     457.  * 24 JAN 1115  69       37.      59.     -22.
23 JAN 2200  16      509.     312.     197.  * 24 JAN 0445  43      815.     299.     516.  * 24 JAN 1130  70       35.      59.     -24.
23 JAN 2215  17      490.     388.     102.  * 24 JAN 0500  44      767.     245.     522.  * 24 JAN 1145  71       33.      57.     -24.
23 JAN 2230  18      474.     629.    -155.  * 24 JAN 0515  45      683.     202.     481.  * 24 JAN 1200  72       31.      55.     -24.
23 JAN 2245  19      491.     797.    -306.  * 24 JAN 0530  46      580.     175.     405.  * 24 JAN 1215  73       30.      55.     -25.
23 JAN 2300  20      559.     912.    -353.  * 24 JAN 0545  47      463.     151.     312.  * 24 JAN 1230  74       29.      51.     -22.
23 JAN 2315  21      669.     969.    -300.  * 24 JAN 0600  48      348.     136.     212.  * 24 JAN 1245  75       28.      51.     -23.
23 JAN 2330  22      790.    1034.    -244.  * 24 JAN 0615  49      256.     116.     140.  * 24 JAN 1300  76       26.      51.     -25.
23 JAN 2345  23      904.    1070.    -166.  * 24 JAN 0630  50      191.     116.      75.  * 24 JAN 1315  77       25.      49.     -24.
24 JAN 0000  24     1011.    1074.     -63.  * 24 JAN 0645  51      146.     108.      38.  * 24 JAN 1330  78       25.      49.     -24.
24 JAN 0015  25     1111.    1072.      39.  * 24 JAN 0700  52      119.     101.      18.  * 24 JAN 1345  79       25.      46.     -21.
24 JAN 0030  26     1208.    1093.     115.  * 24 JAN 0715  53      115.      99.      16.  * 24 JAN 1400  80       25.      40.     -15.
24 JAN 0045  27     1299.    1127.     172.  * 24 JAN 0730  54      130.      99.      31.  *
                                                 *                                                *
*****************************************************************************************************************
1                                                   STATION      051
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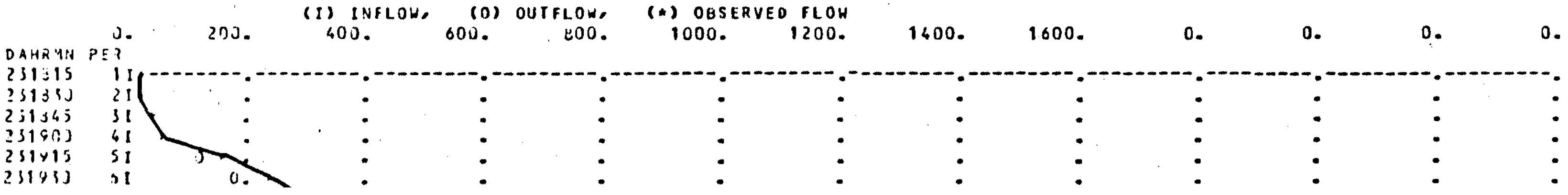


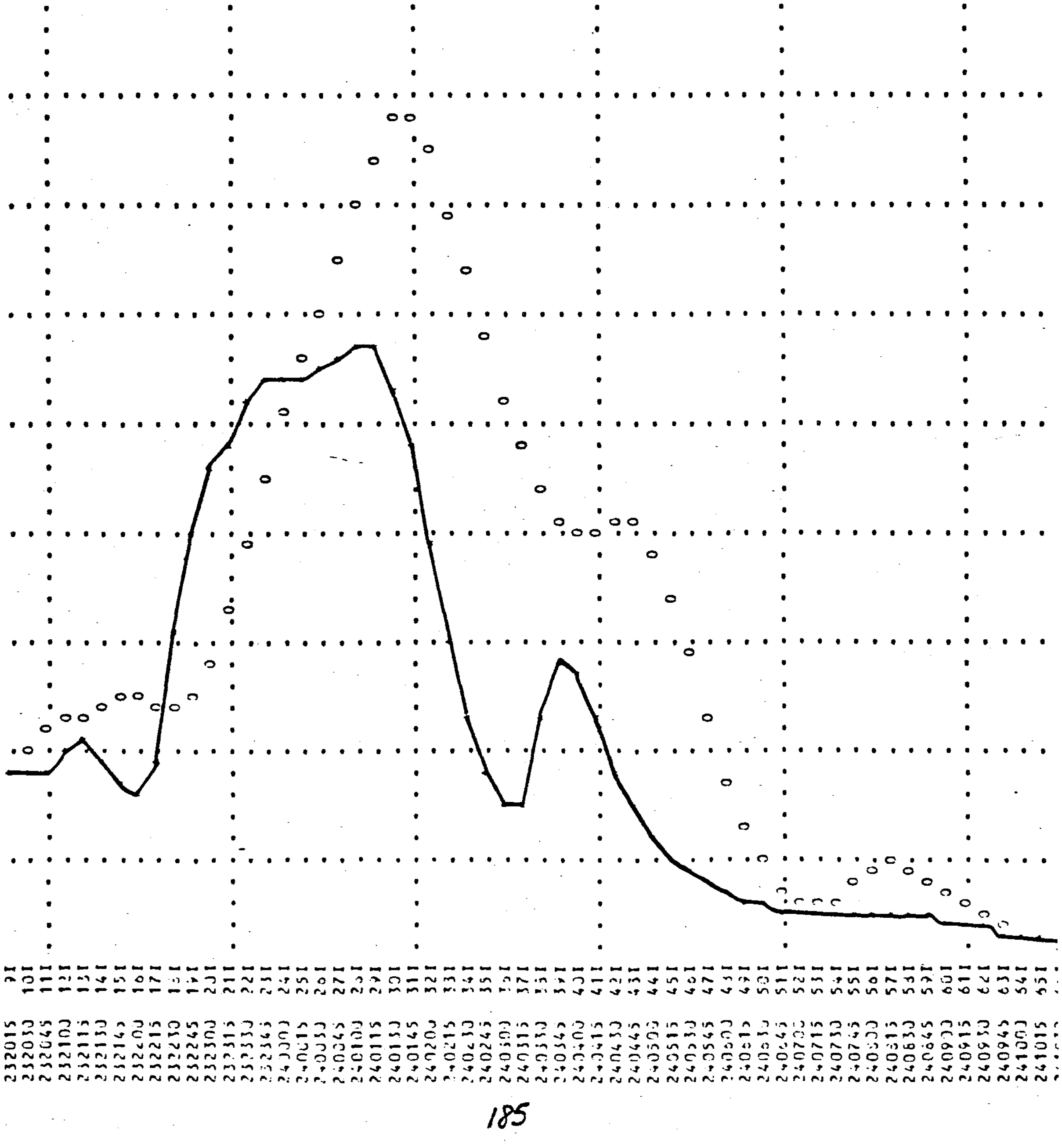
Run 78

Ru.

STORM 1 (with directly input observed Hydrog
of Area 4).

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to peak
Computed	37554	469	7.87	1556	7.50
observed	27370	342	7.25	1149	6.75
Diff.	10184	127	0.63	407	0.75
%	37.21%			35.42%	

standard Error: 285
Ave. Abs. Error: 180
Ave. % Abs. Error: 60.36%

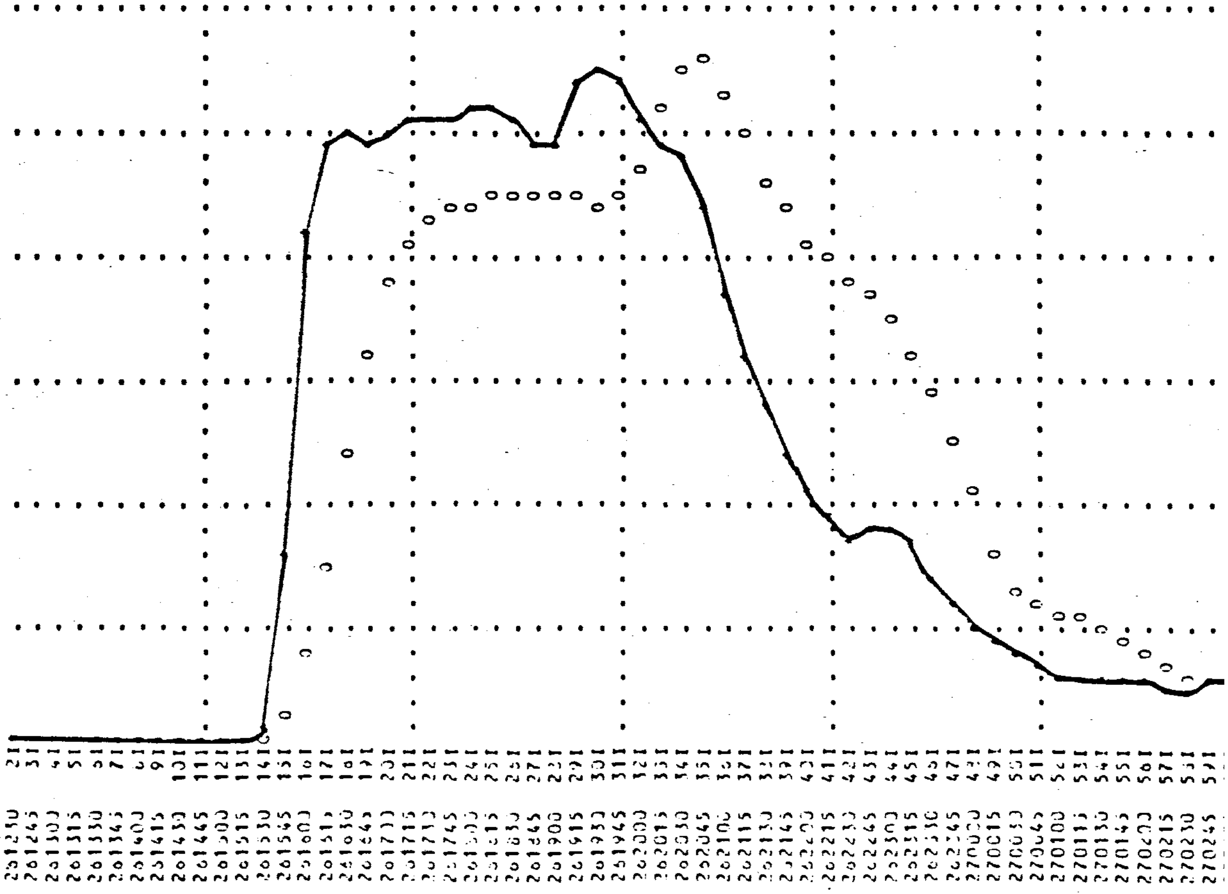


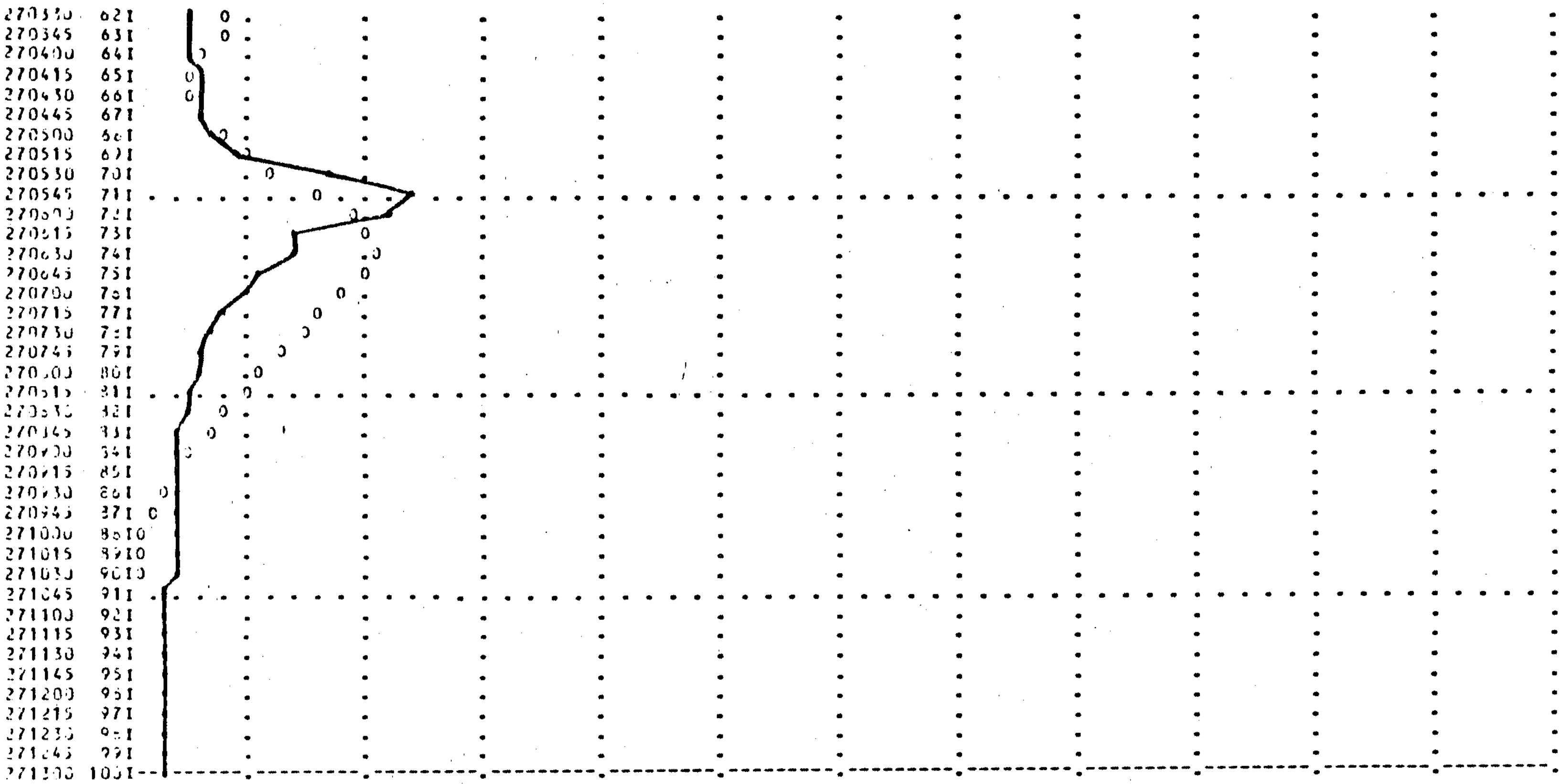
Run

STORM. 2 With modified DLTKR, Tc

	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to peak.
Computed	34302	343	10.13	1115	8.50
Observed	32721	327	9.36	1099	7.25
Diff.	1581	16	0.78	16	1.25
%	4.83%			1.48%	

Standard Error: 192
Ave. Abs. Error: 129
Ave. % Abs. Error: 55.01





```
1
1
                                        RUNOFF SUMMARY
                                  FLOW IN CUBIC FEET PER SECOND
                                TIME IN HOURS,  AREA IN SQUARE MILES

                                       PEAK    TIME OF       AVERAGE FLOW FOR MAXIMUM PERIOD          BASIN      MAXIMUM     TIME OF
            OPERATION        STATION    FLOW      PEAK                                                  AREA       STAGE     MAX STAGE
+                                                              6-HOUR        24-HOUR       72-HOUR

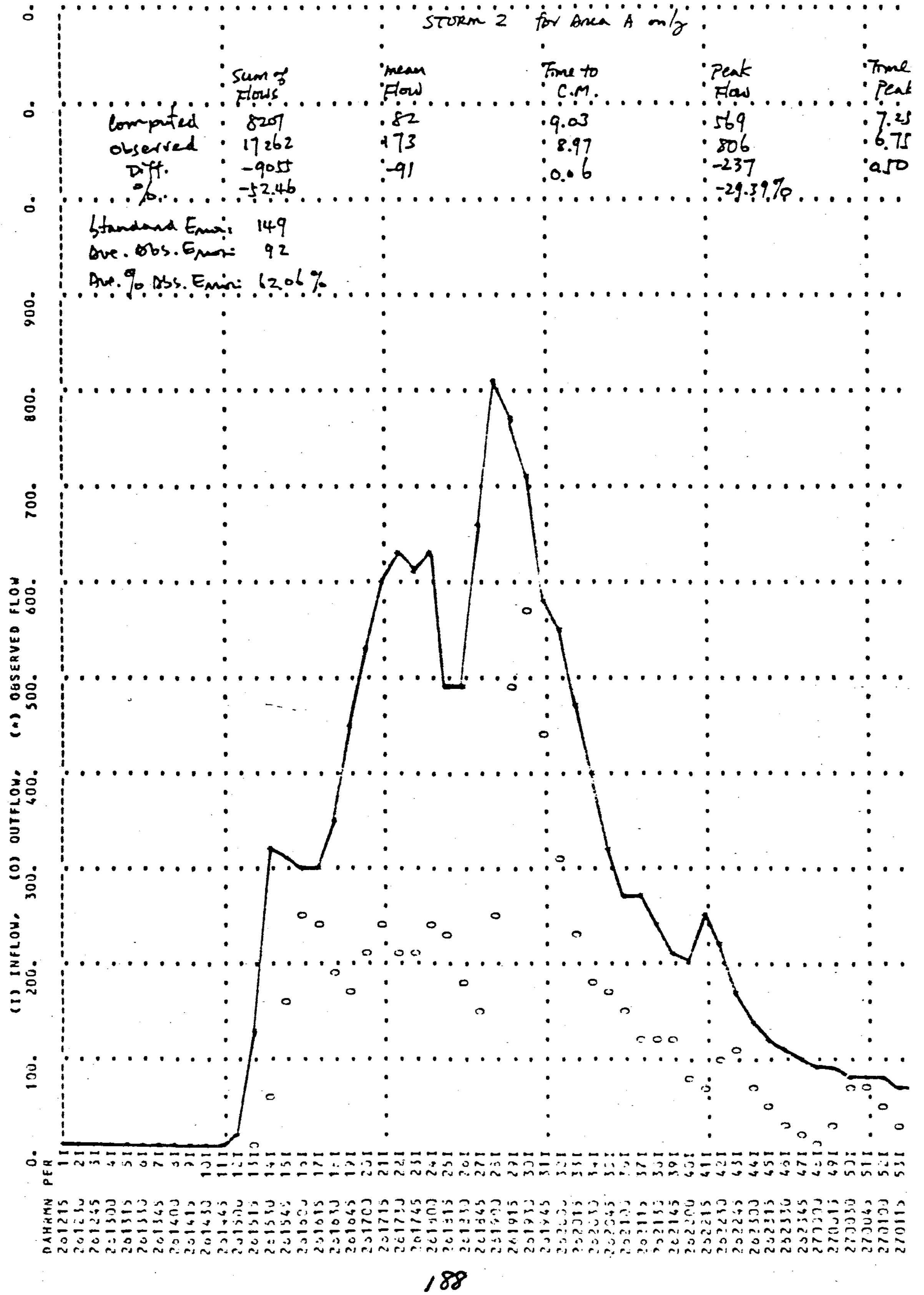
            HYDROGRAPH AT
+                               00A       569.      7.25          236.           85.           83.       2.98

            ROUTED TO
+                              1T02       468.      7.75          235.           86.           83.       2.98

            HYDROGRAPH AT
+                               00B       152.      3.75           90.           31.           30.       0.38
```

Run

Run 80

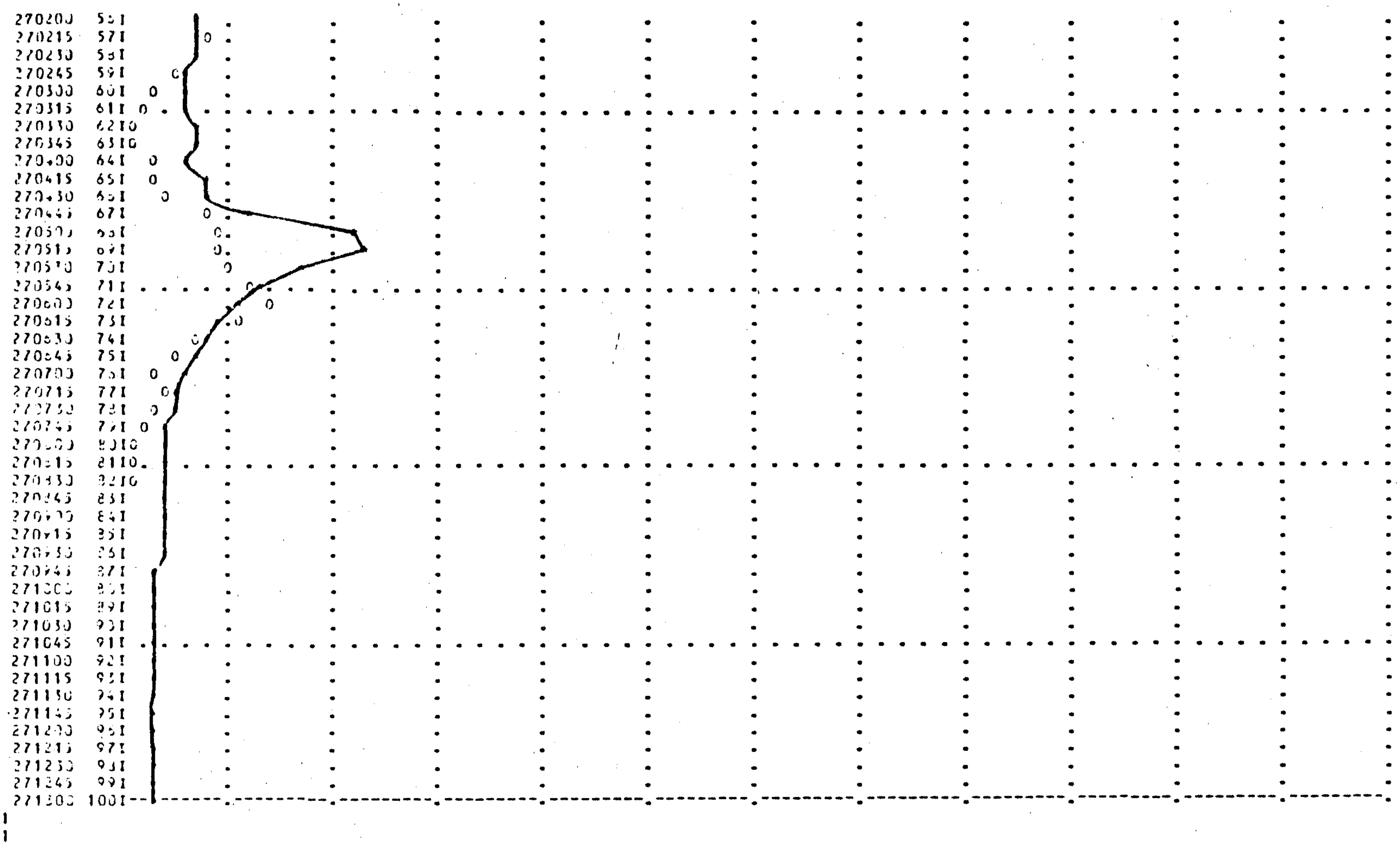


STORM 2 for Area A only

	Sum of Flows	mean Flow	Time to C.M.	Peak Flow	Time Peak
Computed	8207	82	9.03	569	7.25
observed	17262	173	8.97	806	6.75
Diff.	-9055	-91	0.06	-237	0.50
%	-52.46			-29.39%	

Standard Error: 149
Ave. Obs. Error: 92
Ave. % Obs. Error: 12.06%

189



```
                                        RUNOFF SUMMARY
                                 FLOW IN CUBIC FEET PER SECOND
                              TIME IN HOURS,  AREA IN SQUARE MILES

                                      PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM   TIME OF
           OPERATION        STATION   FLOW    PEAK                                             AREA     STAGE    MAX STAGE
+                                                       6-HOUR       24-HOUR      72-HOUR

           HYDROGRAPH AT
+                            00A      569.    7.25        236.          85.          83.        2.98
```

Run 8C

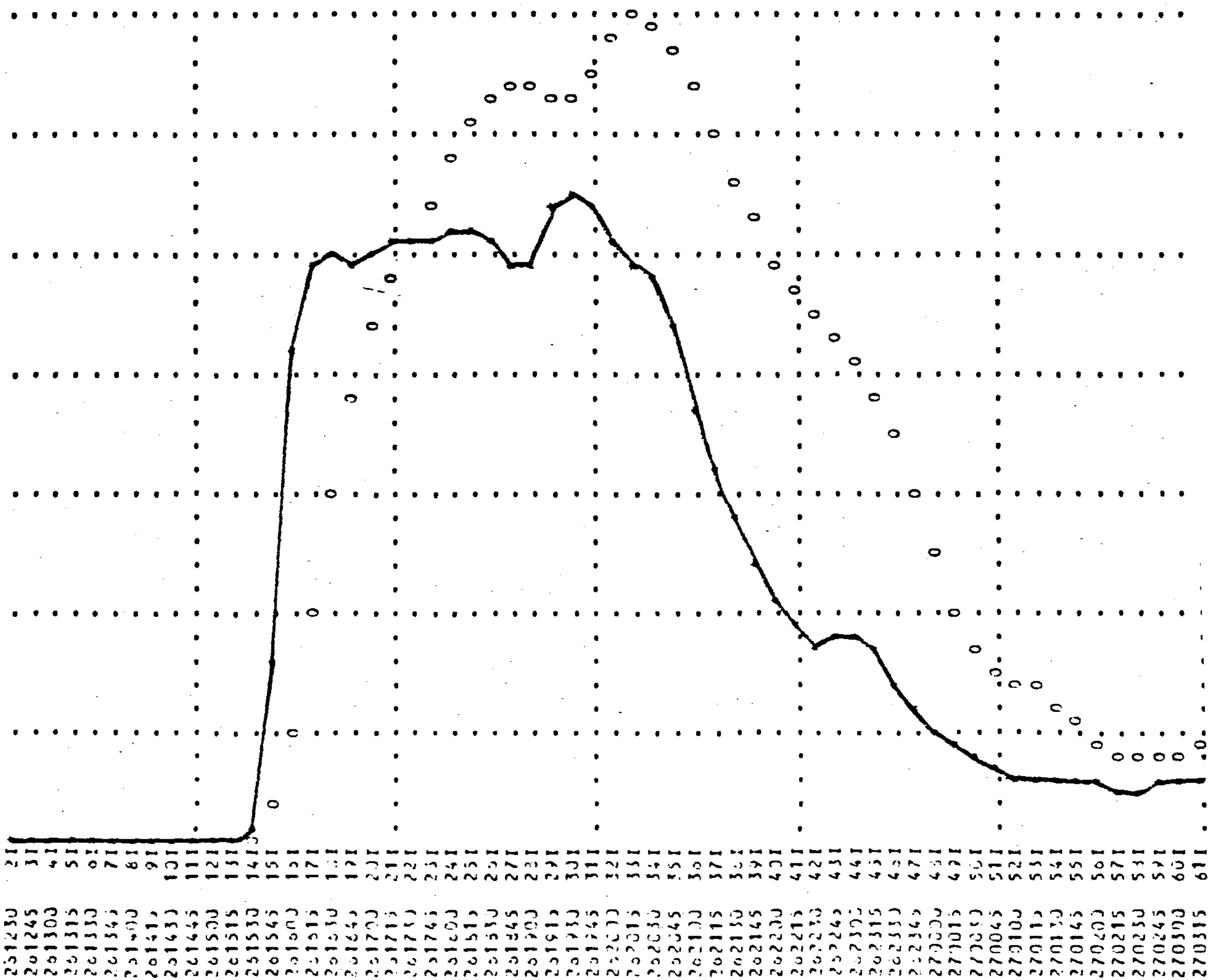
Run

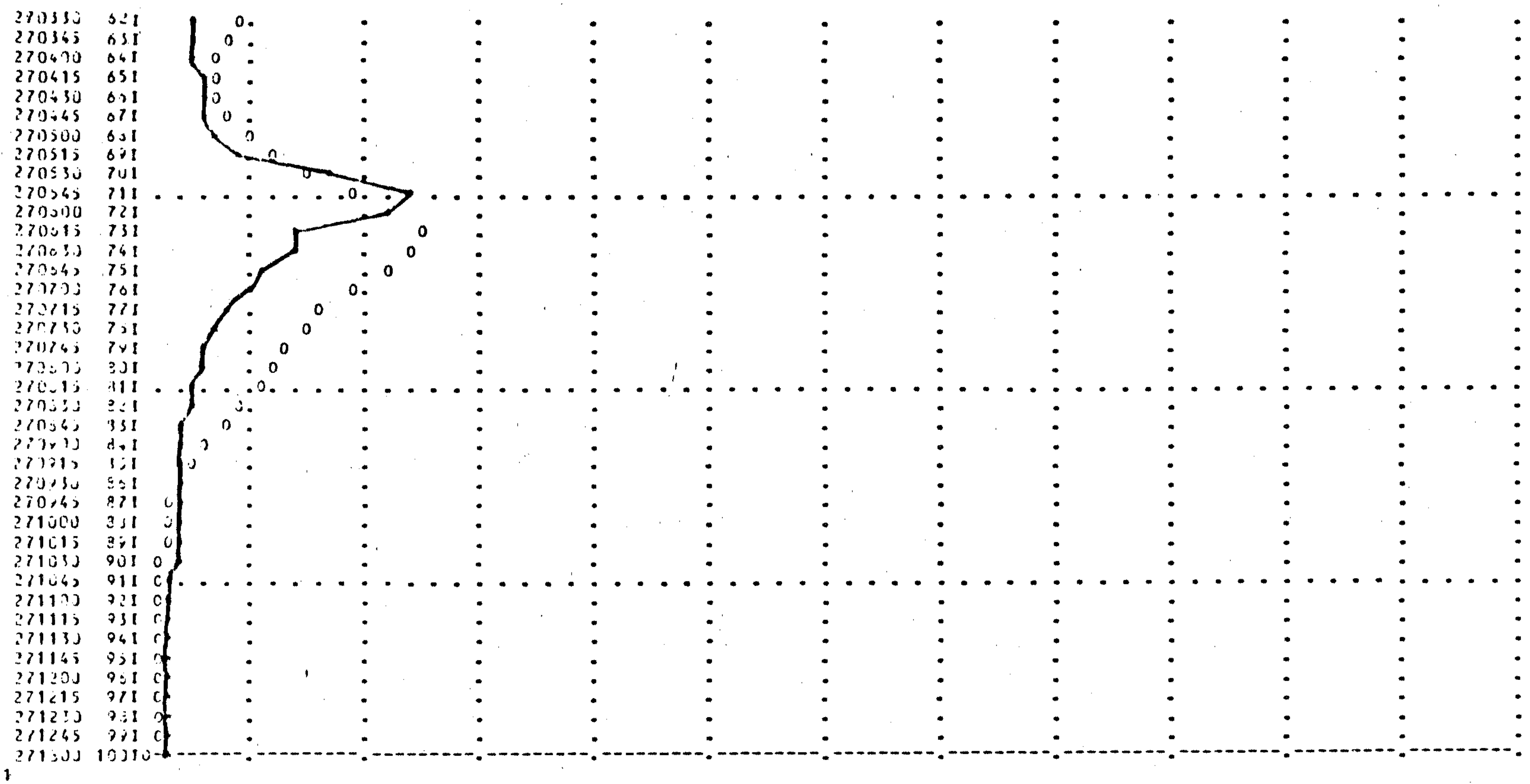
STORM 2 (with Input observed Hydrograph of Area A)

	Sum of Flows	mean Flow	Time to C.M.	peak Flow	Time to peak
Computed	43245	432	10.07	1392	8.00
observed	32721	327	9.36	1099	7.25
Diff.	10524	105	0.71	293	0.75
%	32.16%			26.65%	

Standard Error: 241
Ave. Abs. Error: 161

Ave. % Abs. Error: 59.33%





```
1
1
                                          RUNOFF SUMMARY
                                   FLOW IN CUBIC FEET PER SECOND
                                TIME IN HOURS,  AREA IN SQUARE MILES

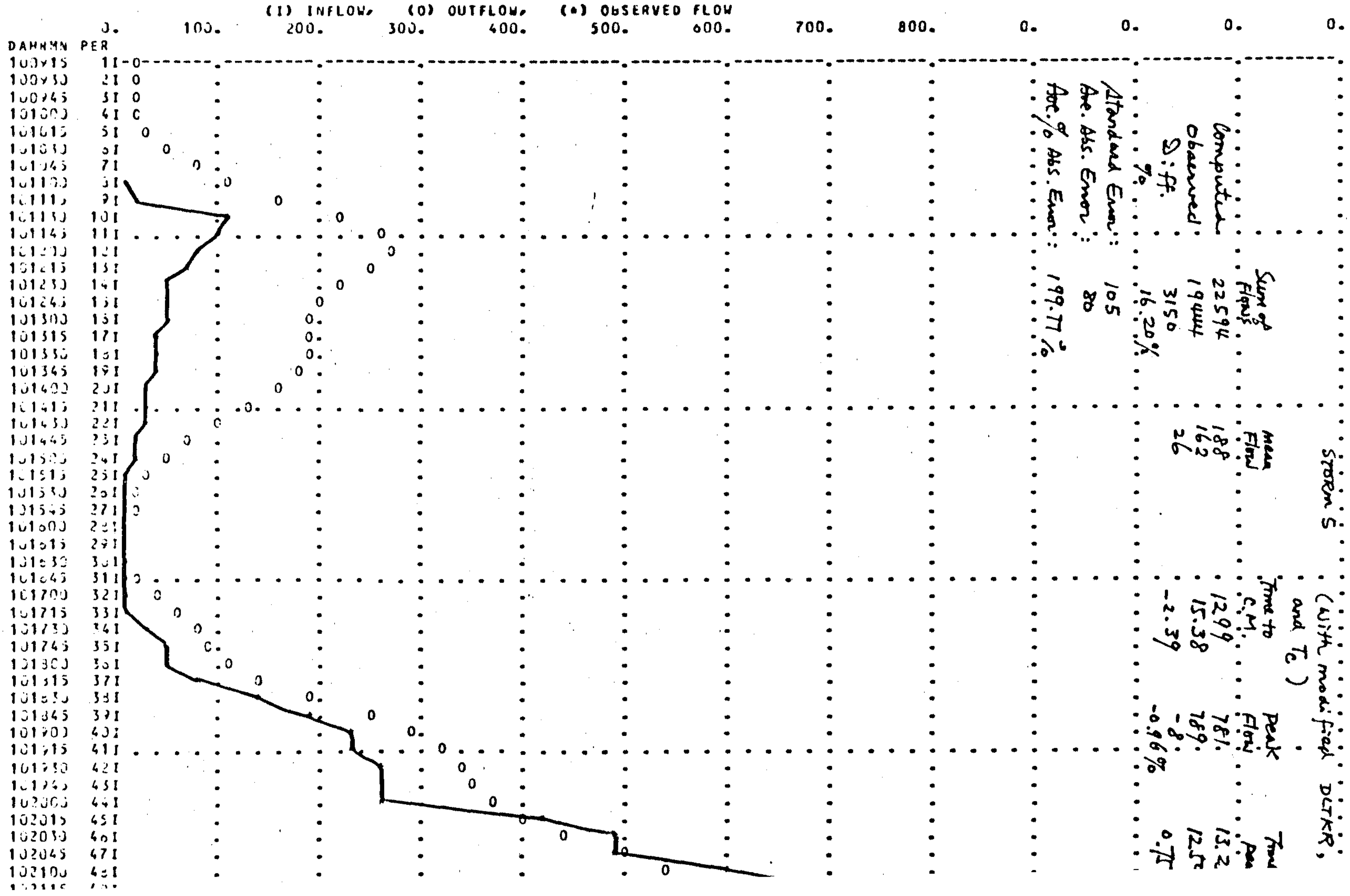
                                         PEAK   TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM    TIME OF
          OPERATION       STATION        FLOW    PEAK                                            AREA     STAGE    MAX STAGE
+                                                           6-HOUR      24-HOUR      72-HOUR

          HYDROGRAPH AT
+                             00A        806.    6.75        490.        179.         174.       2.98

          ROUTED TO
+                            1T02        749.    7.25        467.        179.         174.       2.98

          HYDROGRAPH AT
+                             00B        152.    3.75         90.         31.          30.       0.38
```

```
 10 APR 1330  38       193.      136.       57. * 11 APR 0430  78       340.      180.       160. * 11 APR 1430 118        0.      43.      -43.
 10 APR 1345  39       245.      192.       54. * 11 APR 0445  79       276.      150.       126. * 11 APR 1445 119        0.      41.      -41.
 10 APR 1900  40       290.      234.       56. * 11 APR 0500  80       211.      132.        79. * 11 APR 1500 120        0.      40.      -40.
                                                 *                                                 *
*****************************************************************************************************************************************
1                                                                STATION      051
```



Run

STORM 5 (With modified DLTKR, and Tc)

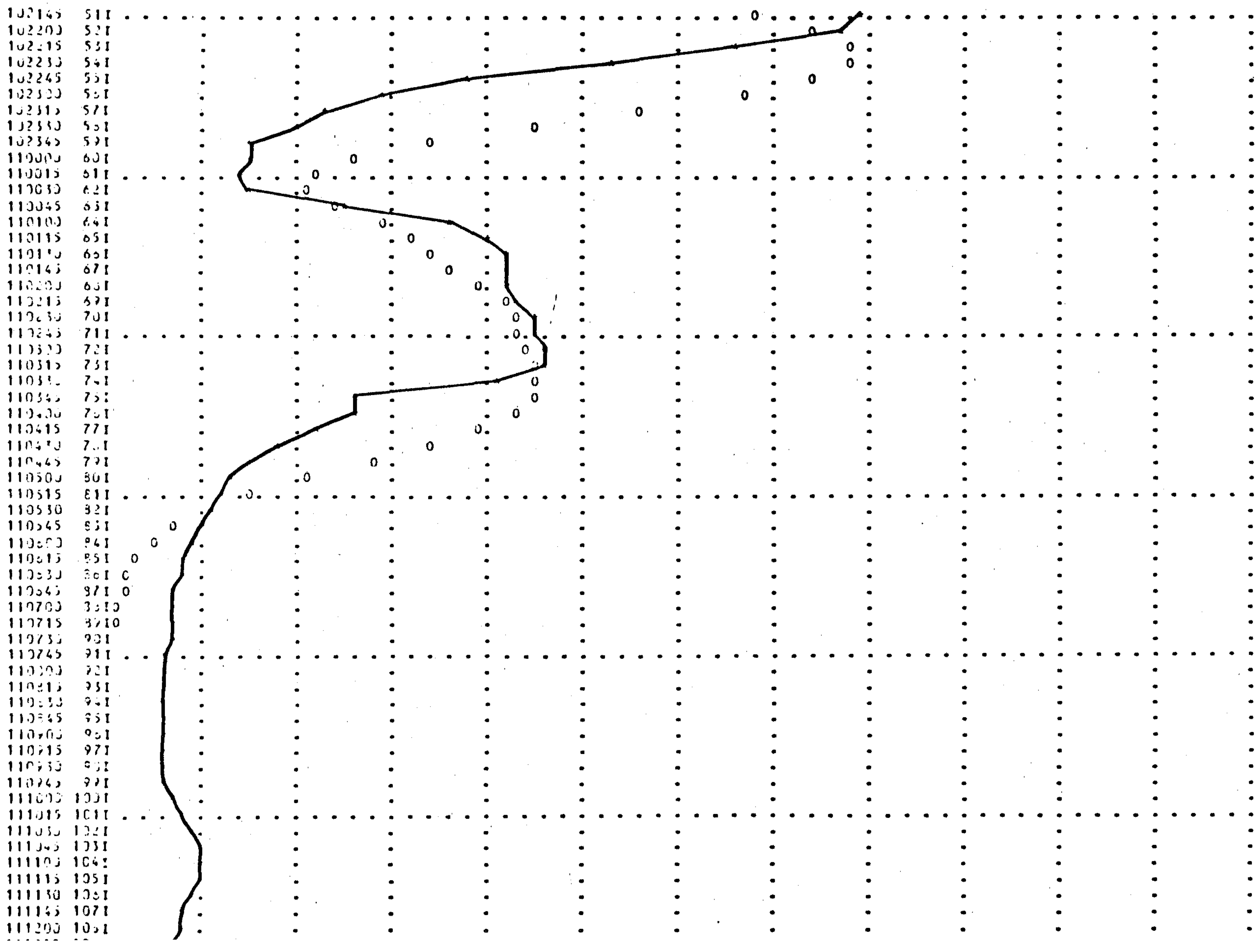
	Sum of Flows	Mean Flow	Time to C.M.	Peak Flow	Time to pea
Computed	22594	188	12.99	781.	13.2
Observed	19444	162	15.38	789.	12.5
Diff.	3150	26	-2.39	-8.	0.7
%	16.20%			-0.96%	

Standard Error: 105

Ave. Abs. Error: 80

Ave. % Abs. Error: 199.77%

Run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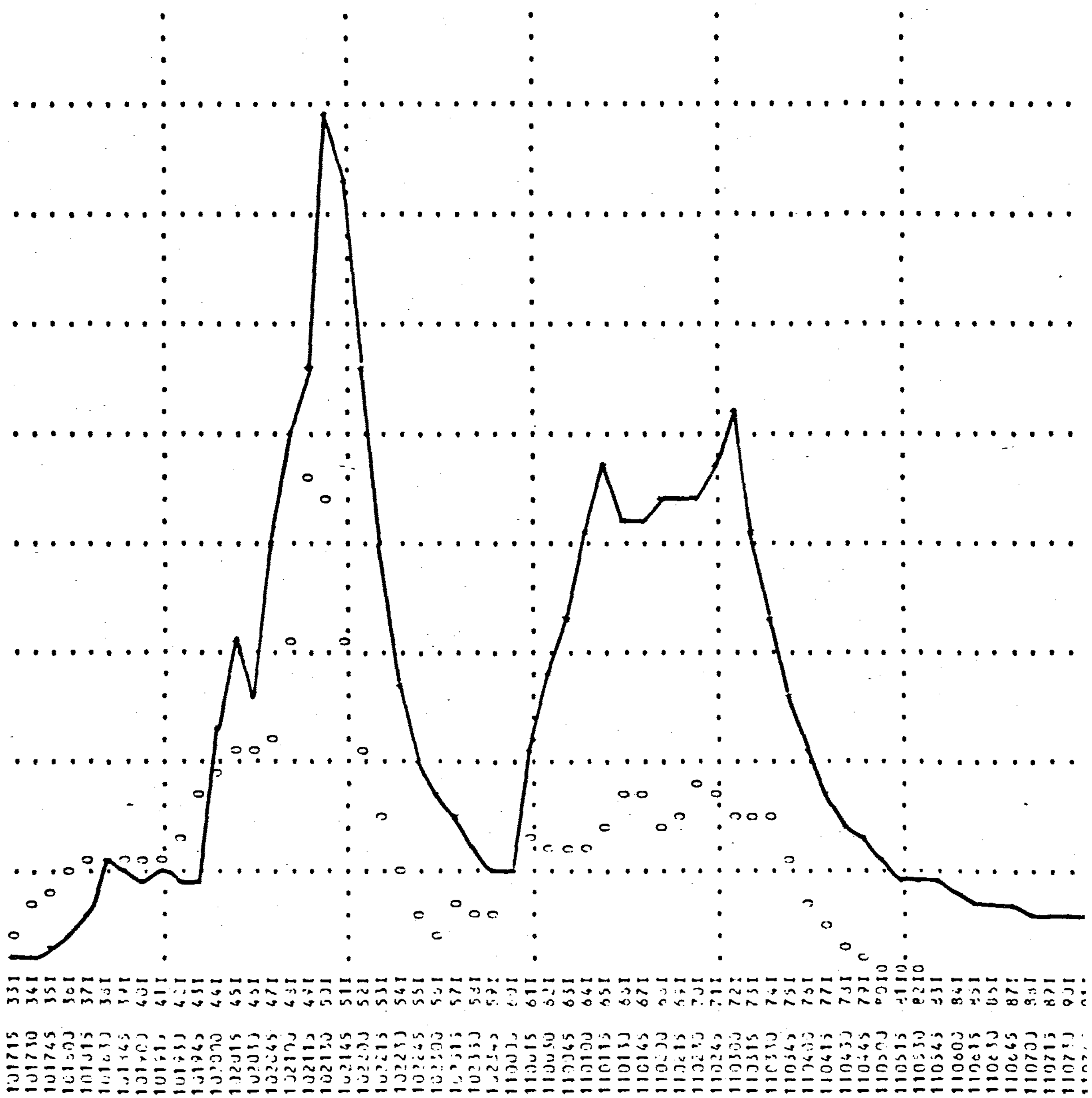
102200 52I
102215 53I
102230 54I
102245 55I
102300 56I
102315 57I
102330 58I
102345 59I
110000 60I
110015 61I
110030 62I
110045 63I
110100 64I
110115 65I
110130 66I
110145 67I
110200 68I
110215 69I
110230 70I
110245 71I
110300 72I
110315 73I
110330 74I
110345 75I
110400 76I
110415 77I
110430 78I
110445 79I
110500 80I
110515 81I
110530 82I
110545 83I
110600 84I
110615 85I
110630 86I
110645 87I
110700 88I
110715 89I
110730 90I
110745 91I
110800 92I
110815 93I
110830 94I
110845 95I
110900 96I
110915 97I
110930 98I
110945 99I
111000 100I
111015 101I
111030 102I
111045 103I
111100 104I
111115 105I
111130 106I
111145 107I
111200 108I

Run

STORM 5 on subarea A only

	sum of flows	mean Flow	Time to C.M.	peak Flow	Time of peak
Computed	3839	32	1245	229	12.00
observed	8055	67	16.07	397	12.25
Diff.	-4216	-35	- 3.62	-168	-0.25
%	-52.33%			-42.2%	

Standard Error: 63
Ave. Abs. Error: 43
Ave. % Abs. Error: 110.31%



```
 10 APR 1330  38      175.      136.       39. * 11 APR 0430  78      457.      180.      277. * 11 APR 1430 118      22.      43.     -21.
 10 APR 1345  39      224.      192.       32. * 11 APR 0445  79      372.      150.      222. * 11 APR 1445 119      22.      41.     -19.
 10 APR 1900  40      267.      234.       33. * 11 APR 0500  80      291.      132.      159. * 11 APR 1500 120      21.      40.     -19.
```

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1                                                   STATION      051
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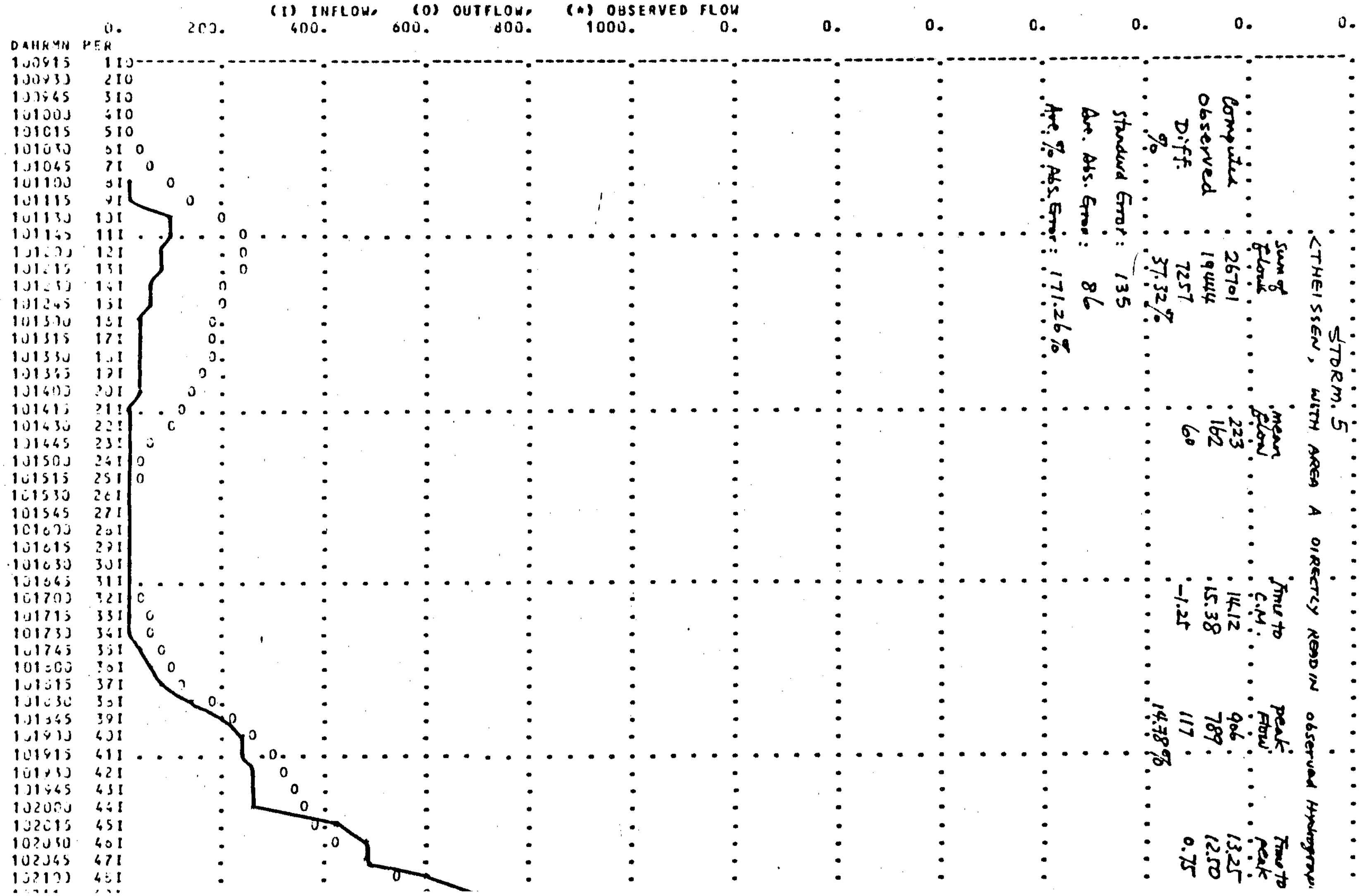

STORM. 5
<THEISSEN, WITH AREA A DIRECTLY READ IN observed Hydrograph

	Sum of flow	mean flow	Time to C.M.	peak flow	Time to peak
Computed	26701	223	14.12	906	13.25
Observed	19444	162	15.38	789	12.50
Diff.	7257	60	-1.25	117	0.75
%	37.32%			14.38%	

Standard Error: 135
Ave. Abs. Error: 86
Ave. % Abs. Error: 171.26%

Run (

Run 81